

**Evaluating a  
Post-Implementation Electronic Medical Record  
Training Intervention for  
Diabetes Management in Primary Care**

by

Gurprit Kaur Randhawa

B.Sc., Health Information Science (with Distinction), University of Victoria, 2011

M.Sc., Health Information Science (with Thesis), University of Victoria, 2013

Graduate Certificate in Learning & Teaching in Higher Education (LATHE), University  
of Victoria, 2016

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University of Victoria

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## **Supervisory Committee**

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#### **Supervisory Committee**

Dr. Karen Courtney, School of Health Information Science, University of Victoria

**Co-Supervisor**

Dr. Aviv Shachak, Institute of Health Policy, Management and Evaluation and Faculty of  
Information (iSchool), University of Toronto

**Co-Supervisor**

Dr. Andre Kushniruk, School of Health Information Science, University of Victoria

**Departmental Member**

## Abstract

Electronic medical records (EMR) can be used by Primary Care Physicians (PCP) to support diabetes care in a proactive and planned way. Although the majority of Canadian PCPs have adopted an EMR, advanced use of the EMR is limited. The literature widely suggests that end-user-support (EUS) is a critical success factor for increasing use of advanced EMR features, such as diabetes registries and recalls or reminders. Training is one type of EUS that is intended to help PCPs to better use their EMRs; however, many PCPs receive little or inadequate EMR training, especially following the implementation of an EMR. Specifically, there is a dearth of literature on the use of video tutorials to improve EMR use. The purpose of this mixed methods (QUAN(qual)) study was to evaluate the potential for EMR video tutorials to improve process measures for type 1 and type 2 diabetes care for PCPs using OSCAR EMR in British Columbia. EMR video tutorials were developed based on the Chronic Care Model, value-adding EMR use, evidence-based video tutorial design, clinician-led EMR training, the Structure-Process-Outcome Model, and the New World Kirkpatrick Model. In total, 18 PCPs participated in the study, and 12 of them participated in 21 follow up interviews. The study results demonstrated that the study intervention and Hawthorne effect elicited a statistically significant increase in EMR feature use for diabetes care, with a large effect size (i.e.,  $F(3, 51) = 6.808, p < .001, \text{partial } \eta^2 = .286$ ). Multiple barriers and facilitators to applying the tutorial skills into practice were also found at the physician, staff, patient, EMR, and policy levels, such as time, funding, computer literacy of staff, patient responsibility, and user-friendliness of the EMR. Three pairs of PCP characteristics had a strong and positive association, which was statistically significant: (1) age and years of practice; (2) years of experience using OSCAR EMR and number of EMRs used; and (3) computer skills and EMR skills. PCPs' years of medical practice was statistically significant in predicting their baseline use of the EMR for diabetes care. Graphical trends indicated that higher

increases in mean composite EMR use (MCEU) score for diabetes care over the duration of the study were associated with PCPs with the following characteristics: (1) being female, (2) being aged 35-44, (3) being from Vancouver Island, (4), having less than four years of medical practice, (5) having 3-4 years of EMR experience, (6) having 1-2 years of OSCAR EMR experience, (7) using four EMRs, and (8) having prior post-implementation EMR training. This small-scale efficacy study demonstrates the potential of CCM-based EMR video tutorials to improve EMR use for chronic diseases such as diabetes. A larger-scale effectiveness study with a control group is needed to further validate the study findings and determine their generalizability.

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## List of Acronyms

<b>BC</b>	British Columbia
<b>CDM</b>	Chronic Disease Management
<b>CCM</b>	Chronic Care Model
<b>EMR</b>	Electronic Medical Record
<b>EHR</b>	Electronic Health Record
<b>EUS</b>	End-User Support
<b>IT</b>	Information Technology
<b>rANOVA</b>	Repeated Measures Analysis of Variance
<b>MD-PET</b>	Management of Diabetes Post-Implementation EMR Training
<b>MOA</b>	Medical Office Assistant
<b>MU</b>	Meaningful Use
<b>PITO</b>	Physician Information Technology Office
<b>PCP</b>	Primary Care Physician
<b>PSP</b>	Practice Support Program
<b>PSP-TG</b>	Practice Support Program - Technology Group

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# Chapter 1: Introduction

## 1.1 Background of the Study

Non-communicable diseases (NCDs) or chronic diseases are "the number one cause of death and disability in the world" (Pan American Health Organization, n.d., para 2) and are responsible for 63% of deaths worldwide (Bloom et al., 2011) and 43% of the global disease burden (World Health Organization, 2016). The four main NCDs leading to mortality and morbidity include cardiovascular diseases (including heart disease and stroke), diabetes, cancer, and chronic respiratory diseases (including chronic obstructive pulmonary disease and asthma) (Bloom et al., 2011).

**Diabetes** is a chronic disease that occurs when the body cannot sufficiently produce or properly use insulin (Public Health Agency of Canada (PHAC), 2011). According to the International Diabetes Federation, diabetes is one of the most challenging health problems in the 21st century (Sicree, Shaw, & Zimmet, n.d.). Uncontrolled diabetes results in consistently high blood sugar levels (i.e., hyperglycemia), which can damage blood vessels, nerves, and various organs (e.g., kidneys, eyes, and heart) over time, resulting in serious complications and death (PHAC, 2011). Diabetes-associated chronic complications include vision disorders, neuropathy, peripheral vascular disease and stroke, which are major causes of physical disability and mortality. Diabetes is also a major risk factor for circulatory and heart disease. Patients

with diabetes are two to four times more likely to develop cardiovascular disease and about two thirds die from it (Swerissen, Duckett, & Wright, 2016; Wan et al., 2006).

According to the Medical Expenditure Panel Survey (MEPS) in the United States, diabetes is the second highest priority condition to manage following cancer based on its prevalence, expense, and policy relevance (Institute of Medicine, 2001). In Canada, diabetes care gaps can cause serious complications for patients and increased costs for the Canadian health care system (Canadian Institute for Health Information (CIHI), 2009). A British Columbia (BC) study found that adults with diabetes used, on average, 2.4 times the health resources of the general population (Broemeling & Watson, 2005). Hence, diabetes care is a priority condition for policy-makers, health system managers and health care providers (CIHI, 2009).

To address the need for continuity, comprehensiveness, and coordination of care, **primary care** has been suggested to play a key role in the management of NCDs (Rothman & Wagner, 2003), especially diabetes care. Almost 80% of diabetes care is provided in the primary care setting (Clement, Harvey, Rabi, Roscoe, & Sherifali, 2013) by primary care physicians (PCPs). As defined by the United States Institute of Medicine (IOM), primary care is "the provision of integrated, accessible health care services by clinicians who are accountable for addressing a large majority of personal health care needs, developing a sustained partnership with patients and practicing within the context of family and community" (Donaldson et al., 1996, p. 31).

International research indicates that less than half of patients with diabetes have recommended levels for important risk factors, referred to as "ABCs" or "3Bs", which

include glycosylated hemoglobin (referred to as Hemoglobin A1C, HbA1C, or A1C) or blood sugar, blood pressure, and cholesterol or blood lipids (Beaton et al., 2004; Goderis et al., 2009; Sundquist, Chaikiat, Leon, Johansson, & Sundquist, 2011). At the same time, patients' needs for "whole-person, integrated care" are largely unmet (Safran, 2003).

The IOM describes the difference between usual care and evidence-based appropriate care as the "quality chasm" (Institute of Medicine, 2001), and suggests that the quality chasm is due to "outdated systems of work" (p. 4). As per the IOM (2001) report entitled "Crossing the Quality Chasm", problems with quality occur "typically not because of failure of goodwill, knowledge, effort or resources devoted to healthcare, but because of fundamental shortcomings in the way care is organized" (p. 25). As such, the IOM (2001) recommended the need for health care system redesign, including "the use of information technology to support clinical and administrative processes" (p. 4). The **electronic medical record** (EMR) is one such tool that can support clinical and administrative processes.

An EMR is a computer-based patient record that allows for the collection, storage, and display of patient information. EMRs are maintained by PCPs and typically include demographics, medical and drug history, diagnostic information, billing, and scheduling capabilities (Shachak, Barnsley, & Tu, 2011). Most EMRs also have advanced features such as reminders/alerts, which have significant potential to support diabetes care management in a proactive and planned way. Although the majority of PCPs around the world have adopted an EMR, their EMR use in Canada and the United States varies. A 2013 report by Canada Health Infoway revealed that only 3% of PCPs reported using

their EMR for managing NCDs. In 2014 (the latest available data from the National Physician Survey), over half (55%) of PCPs indicated that they planned to use reminders for recommended care in the next two years. However, 17% of PCPs indicated that training was a barrier in accessing their EMR (National Physician Survey, 2014b). In 2013, post-implementation training and support to enable maturity of EMR use to realize EMR benefits was also identified as a national research priority (Canada Health Infoway, 2013).

The literature widely suggests that **end-user-support (EUS)** is a critical success factor for increasing use of advanced EMR features (Cresswell & Sheikh, 2013; Dawes & Chan, 2010; Denomme, Terry, Brown, Thind, & Stewart, 2011; Druss & Mauer, 2010; Holden, 2011; Jones, Rudin, Perry, & Shekelle, 2014; Lluch, 2011; Shachak, Barnsley, Montgomery, et al., 2012; Watkinson-Powell & Lee, 2012). EUS is "any information or activity that is intended to help physicians solve problems with, and better utilize, the system" (Shachak, Barnsley, Montgomery, et al., 2011, p. 170). However, many PCPs receive little effective (Fernald, Wearner, & Dickinson, 2013) or adequate EUS (Crosson et al., 2011; Dastagir et al., 2012; Fernald et al., 2013; Haugen, 2012; Kim, Clarke, Belden, & Hinton, 2014; Smith, 2013), especially following the implementation of an EMR. In particular, training is an important type of EUS that the majority of PCPs currently lack, especially post-implementation EMR training (Bredfeldt, Awad, Joseph, & Snyder, 2013; Dastagir et al., 2012; Edwards, Kitzmiller, & Breckenridge-Sproat, 2012; Goveia et al., 2013). A recent Canadian study also highlights the need to invest in training and education initiatives for current PCPs to improve their use of the EMR (Vaghefi et al., 2016).

## **1.2 The Problem of the Study**

Given the current gaps or "quality chasm" in diabetes care, there is an urgent need to improve the quality of diabetes care across the globe; EMRs are one tool that can support this effort. Specifically, there is a need to understand how diabetes management in primary care can be improved through post-implementation EMR training. This dissertation describes a research study that was undertaken to address this issue.

## **Chapter 2: Background Literature Review**

### **2.1 Chronic Diseases in Canada**

In Canada, 40% of people have at least one NCD (Kadu & Stolee, 2015). Moreover, 60% of Canadians aged 20 years or older have been diagnosed with a chronic disease (Betancourt et al., 2014). Costing approximately \$68 billion in 2010, NCDs are a major driver of health care expenditures in Canada (Kadu & Stolee, 2015). They are also the leading cause of death and hospitalization for Canadians (Public Health Agency of Canada (PHAC), 2005). In addition to the detrimental impact on quality of life, chronic diseases account for over 33% of direct health care costs in Canada (Ontario Ministry of Health & Long Term Care, 2007). As a result, the management of chronic disease is the biggest challenge currently facing the Canadian health care system. Over two-thirds (67%) of deaths in Canada are due to chronic disease (PHAC, 2016).

### **2.2 Diabetes**

#### **2.2.1 Definition**

Diabetes is "a chronic disease in which the body either cannot produce insulin or cannot properly use the insulin it produces" (Diabetes Canada, 2018, para. 2). Insulin is a hormone that helps the body control the level of glucose (i.e., sugar) in the blood (Diabetes Canada, 2018b). Specifically, insulin "triggers the uptake of glucose, fatty acids and amino acids into liver, adipose tissue and muscle and promotes the storage of these nutrients in the form of glycogen, lipids and protein respectively" (Hooper, 2018,

para. 1). The insulin signal transduction pathway is the biochemical pathway that facilitates this process. Due to defects in insulin signal transduction pathway, glucose is not used for energy storage in the form of glycogen (Hooper, 2018). Instead, glucose accumulates in a person's blood (Diabetes Canada, 2018b). The inability to produce insulin or use it effectively leads to hyperglycemia. Over the long-term, high glucose levels can lead to damage to the body and failure of various organs and tissues (International Diabetes Federation (IDF), 2018a).

### **2.2.2 Types of Diabetes**

There are three types of diabetes: type 1, type 2, and gestational. Although all three types are characterized by insufficient production or use of insulin, they all have different causes, treatments, and complications (PHAC, 2011).

Type 1 diabetes occurs due to an autoimmune reaction that attacks and kills the insulin-producing cells (i.e., beta cells) of the pancreas (Conference Board of Canada, 2015). As such, little or no insulin is released in the body. Consequently, glucose accumulates in the blood instead of being stored as glycogen. About 10% of diabetic patients have type 1 diabetes (Diabetes Canada, 2018c). Although type 1 diabetes generally develops in childhood or adolescence, it can develop in adulthood, as well (Diabetes Canada, 2018c). Type 1 diabetes is treated with insulin (Diabetes Canada, 2018c), and is thereby considered to be "insulin-dependent" (Conference Board of Canada, 2015). However, meal planning assists with keeping blood sugar at appropriate levels (Diabetes Canada, 2018c).

Type 2 diabetes is considered "non-insulin dependent" (Conference Board of Canada, 2015). It occurs when the body cannot properly use the insulin that is released (i.e., insulin insensitively) or does not make enough insulin (Diabetes Canada, 2018c). For this reason, glucose builds up in the blood. Worldwide, almost 90% of diabetic patients have type 2 diabetes. Although adults typically are affected by type 2 diabetes, children may also be affected (Diabetes Canada, 2018c). Type 2 diabetes is managed through diet, regular exercise, medication, and sometimes insulin injections.

Gestational diabetes develops during pregnancy and is detected in 3-5% of all pregnancies (PHAC, 2011). However, it generally disappears after pregnancy (PHAC, 2011). Gestational diabetes occurs when the body is unable to produce enough insulin to handle the effects of a growing baby and changing hormone levels (Diabetes Canada, 2018a). Approximately 3-20% of pregnant women develop gestational diabetes (Diabetes Canada, 2018c). However, having gestational diabetes can increase the risk of the mother and/or child developing Type 2 diabetes (Diabetes Canada, 2018c). Gestational diabetes is managed through diet, achieving normal pregnancy weight gain, being physically active, checking blood sugars at home, and taking medication if needed (Diabetes Canada, 2018a).

Pre-diabetes is a condition that indicates increased risk of Type 2 diabetes. Although not all individuals with pre-diabetes will develop diabetes, the chances of developing diabetes is increased without proper management (PHAC, 2011). However, changes in lifestyle (e.g., diet, physical activity, and weight management) can delay or halt progression to diabetes (PHAC, 2011).

### **2.2.3 Global Snapshot of Diabetes**

According to the most recent diabetes atlas published by the International Diabetes Federation (IDF) in 2017, 425 million people aged 20-79 around the world have diabetes, and this number is expected to grow to 629 million in 2045 (IDF, 2018b). The highest prevalence of diabetes is in high- and middle-income countries. In most countries, Type 2 diabetes is rapidly increasing due to cultural and social changes, aging populations, increasing urbanization, reduced physical activity, increased sugar consumption, and low fruit and vegetable intake (IDF, 2015). As of 2017, it is estimated that 212 million people around the world have undiagnosed diabetes (IDF, 2015). Four million people died due to diabetes in 2017 (IDF, 2018b). Diabetes currently accounts for \$727 billion in global health care expenditures (IDF, 2018b), and is expected to cost \$802 billion in 2040 (IDF, 2015). High-income countries such as the United States and Canada spend vastly more on diabetes-related costs than lower-income countries (IDF, 2017). In fact, half of the global diabetes health care spending occurs in North America and Caribbean region (IDF, 2017).

### **2.2.4 Diabetes in Canada**

Diabetes is one of the most common chronic diseases in Canada (Pelletier et al., 2012). According to the most recent data available from Statistics Canada from 2016, 7.0% of Canadians aged 12 and older (roughly 2.1 million people) have reported being diagnosed with diabetes. As of 2012 (the most recent data available from the Canadian Chronic Disease Surveillance System), over 2.7 million (7.7%) Canadians have diabetes,

which represents 9.8% of adults aged 20 and older, and 0.3% of children aged 1-19 (PHAC, 2016).

The prevalence of diabetes is increasing dramatically due to "Canada's aging population, rising obesity rates, increasingly sedentary lifestyles, and higher risk for diabetes for Aboriginal people and new Canadians" (Conference Board of Canada, n.d., para. 15). Approximately 90-95% of Canadians with diabetes have type 2 diabetes, whereas 5-10% have type 1 diabetes (PHAC, 2011). In 2008/2009, approximately one in ten deaths in Canadian adults were due to diabetes (PHAC, 2011).

### **2.2.5 Diabetes in British Columbia**

In British Columbia (BC), 1.4 million people or 29 per cent of the provincial population, are living with diabetes or pre-diabetes (Diabetes Canada, 2017). As of 2017, approximately 485,000 British Columbians have been diagnosed with diabetes, representing 9.5 per cent of the province's population (Diabetes Canada, 2017). About one-third of British Columbians with diabetes are undiagnosed and 765,000 people have pre-diabetes (Diabetes Canada, 2017).

On average, over 29,000 of British Columbians are diagnosed with diabetes every year (BCGuidelines.ca, 2015). Over the last ten years, the number of people diagnosed with diabetes has increased by approximately 74% (Diabetes Canada, 2017). The prevalence of diabetes in BC is estimated to increase by 44% over the next decade, which would be the second largest increase among provinces in Canada (Diabetes Canada, 2017). By 2027, Diabetes Canada (2017) projects that the number of British Columbians

with diabetes will increase to almost 1.9 million people, which would represent 32% of BC's population.

The cost of diabetes is \$418 million a year for the BC health care system, with approximately \$98-120 million of the cost attributed to diabetes foot ulcers alone (Diabetes Canada, 2017). From 2013 to 2020, the Canadian Diabetes Association (now Diabetes Canada) had estimated that the cost of diabetes (including out of pocket costs) will increase by 25% from 1.5 billion to 1.9 billion. The significant estimated increases in the prevalence and cost of diabetes are partly due to the fact that BC has a concentration of people who are at higher risk of developing type 2 diabetes, including South Asian, Chinese, and Aboriginal populations (Diabetes Canada, 2017), as well as older adults and those who have low income (Diabetes Canada, 2015). In addition, about 40% of British Columbians are not physically active, 60% do not eat enough fruits or vegetables, and 50% of the adult population is overweight or obese (Diabetes Canada, 2017).

### **2.2.6 Management of Diabetes**

Almost 80% of diabetes care is provided in the primary care setting (Clement et al., 2013) by PCPs. The risks and complications of diabetes are reduced through strategies that aim to achieve normal or near normal blood glucose levels and minimize individual modifiable cardiovascular risk factors, such as hypertension, hyperlipidemia, obesity, and smoking (Gamblea & Butalia, 2014). Both non-pharmacologic and pharmacologic interventions are used to control these risk factors. Traditionally, diabetes has been managed by focusing on treating hyperglycemia. However, the management of diabetes is shifting towards a multi-factorial treatment model that focuses on controlling

blood glucose and other risk factors for diabetes-related complications (e.g., hypertension and hyperlipidemia) (Gamblea & Butalia, 2014). The specific recommendations for managing these risk factors are captured in current clinical practice guidelines. Clinical practice guidelines are used in diabetes care management to reflect the most current therapeutic knowledge and guide evidence-based care (Gamblea & Butalia, 2014). Specific targets for diabetes care indicators (e.g., glucose level, blood pressure, cholesterol, weight reduction, etc.) make up the key components of the clinical practice guidelines. Recommendations for periodic examinations for potential complications of diabetes (e.g., urine protein tests for kidney function, eye exams, and foot exams) are also included in the clinical practice guidelines.

In BC, the Diabetes Care (2015) guidelines by BCGuidelines.ca are used. These clinical guidelines should be used in conjunction with clinical judgment and diabetes care management plans should be individualized and modified based on the patient's age, dietary and physical activity habits, social and cultural norms, school/work schedule, comorbidities, and presence of diabetes-related complications (Gamblea & Butalia, 2014).

### **2.2.7 Patient Cost Management of Diabetes in BC**

Given that diabetes is a life-long disease that may require different treatments as it progresses, it is important to note that patients' ability to afford treatment has implications for diabetes care. Public coverage for drug therapy to treat diabetes in BC is dependent on a person's income-level, age, and prescribed therapy (Diabetes Canada, 2017). Patients with type 1 diabetes spend \$800-\$4,700 a year of out-of-pocket to manage their diabetes,

while patients with type 2 diabetes spend between \$1,500- \$1,900 a year (Diabetes Canada, 2017). Although lower income earners may receive financial assistance, this may cover about 22% of the total treatment cost only (Diabetes Canada, 2017). Private insurance is also often difficult to obtain and does not provide complete coverage (Diabetes Canada, 2017). In a 2015 survey, 28% of patients with diabetes in BC reported that the cost of diabetes affected their treatment adherence (Diabetes Canada, 2017).

Compared to other public drug plans in Canada, BC's drug plan (Pharmacare) provides fewer options for diabetic patients. Consequently, public coverage for diabetes-related supports in BC is inadequate (Diabetes Canada, 2017). Specifically, many diabetes medications for newer drug classes are not accessible, the provincial insulin pump program coverage is unavailable to people over 25 years of age, and there is no funding for amputation prevention devices (Diabetes Canada, 2017). BC is the only jurisdiction in Canada in which none of the three medications (i.e., Sodium-glucose co-transporter-2 (SGLT2) inhibitors) for diabetes care are listed on the provincial formulary for public coverage. Further, insulin pumps are available for all ages in Alberta, Ontario, and Yukon/Nunavut/Northwest Territories (Diabetes Canada, 2017). Given that not all British Columbians are able to access or afford diabetes treatment, this limits their ability to effectively manage their diabetes (Diabetes Canada, 2017).

### **2.2.6 Quality of Diabetes Care**

Although there is evidence supporting the use of multi-factorial treatment to manage diabetes care in primary care, there are big, persistent gaps between the clinical goals outlined in evidence-based guidelines for diabetes care and actual clinical practice

around the world (Ali et al., 2013; Beaton et al., 2004; Glasgow & Strycker, 2000; Goderis et al., 2009; Ji et al., 2013; Kumar & Modi, 2016; Si, Bailie, Wang, & Weeramanthri, 2010; Stone et al., 2013; Sundquist et al., 2011), as well as in Canada (Braga et al., 2010; Clement et al., 2013; Harris et al., 2011; Harris, Ekoé, Zdanowicz, & Webster-Bogaert, 2005; Leiter et al., 2013).

A recent national cross-sectional survey (i.e., the Diabetes Mellitus Status in Canada survey) of 479 PCPs (data was submitted on 5123 patients) reveals the quality chasm associated with diabetes care and the challenges that PCPs face in achieving glycemic control and global vascular protection in patients with type 2 diabetes. The study reports that only 13% of patients had achieved the three targets for all three ABCs (i.e., A1C, blood pressure, cholesterol) (Leiter et al., 2013). Only half of the patients had met the A1C targets (i.e.,  $A1C \leq 7.0\%$ ), while 57% met the cholesterol targets (i.e.,  $LDL-C \leq 2.0$  mmol/L) and 36% had a blood pressure  $\leq 130/80$  mm Hg (Leiter et al., 2013). Further, only 38% of patients received diet counseling while over 80% of patients were prescribed antihyperglycemic agents (87%), lipid-lowering therapy (81%), and antihypertensive agents (83%) (Leiter et al., 2013). These findings are similar to earlier findings from the Diabetes in Canada Evaluation (DICE) Study (Harris et al., 2005), the Diabetes Registry to Improve Vascular Events (DRIVE) study (Braga et al., 2012), and the Canadian First Nations Diabetes Clinical Management Epidemiologic (CIRCLE) study.

Data from a 2009 report on "Diabetes Care Gaps and Disparities in Canada" by the Canadian Institute for Health Information (CIHI) also highlights the quality chasm in

diabetes care. In general, adult patients with diabetes were found to receive less care than is recommended for HbA1C tests, urine protein tests, dilated eye exams, foot exams, influenza immunizations and self-managed care (CIHI, 2009).

Although 81% of adults with diabetes reported having one or more HbA1C tests in the last 12 months, only half of adults (51%) had their feet checked by a health care professional (CIHI, 2009). Almost three quarters of adult patients with diabetes reported having their urine tested for protein within the last year and only two-thirds (66%) reported having a dilated eye exam in the last two years (CIHI, 2009). Only about one third of patients with diabetes (32%, age-standardized) reported receiving all four of these recommended care components (CIHI, 2009). Although it is unclear if this was due to lack of providing recommended care or due to poor data quality, these gaps suggest that there is an opportunity to improve the quality of diabetes care in all Canadian jurisdictions.

To bridge the gaps between current practices and optimal standards, the redesign of primary care has been proposed (Institute of Medicine, 2001). This redesign requires a systematic approach that emphasizes self-management, care planning with a multidisciplinary team, and ongoing assessment and follow-up (Wagner, Austin, & Von Korff, 1996). To redesign or improve primary care for effective chronic disease management, the Chronic Care Model has been recommended (Bodenheimer, Wagner, & Grumbach, 2002; Edward Wagner et al., 2001). Specifically, clinical information systems (e.g., EMR) can play a key role in facilitating improved capture, organization, and

presentation of patient information. EMRs can also provide clinic-based population management tools and decision support functionalities to support chronic disease care.

### **2.3 The Chronic Care Model**

A number of organizational models for chronic disease management (CDM) have been described in the literature, such as the Chronic Care Model (CCM) (Wagner et al., 2001) and its adaptations, including the Expanded Chronic Care Model (Barr et al., 2003), Chronic Disease Prevention and Management Model (Ontario Ministry of Health & Long Term Care, 2007), the Innovative Care for Chronic Conditions (ICCC) Framework (Epping-Jordan, Pruitt, Bengoa, & Wagner, 2004), and the eHealth Enhanced Chronic Care Model (Gee, Greenwood, Paterniti, Ward, & Miller, 2015). To guide research on diabetes care, this study proposes the use of the CCM, which has been accepted almost universally as a validated model for managing chronic care in the primary care setting. It has also been extensively applied to diabetes care (Baptista et al., 2016; Ji et al., 2013; Kaissi & Parchman, 2009; Mohler & Mohler, 2005; Ouwens, Wollersheim, Hermens, Hulscher, & Grol, 2005; Ramli et al., 2014; Renders et al., 2001).

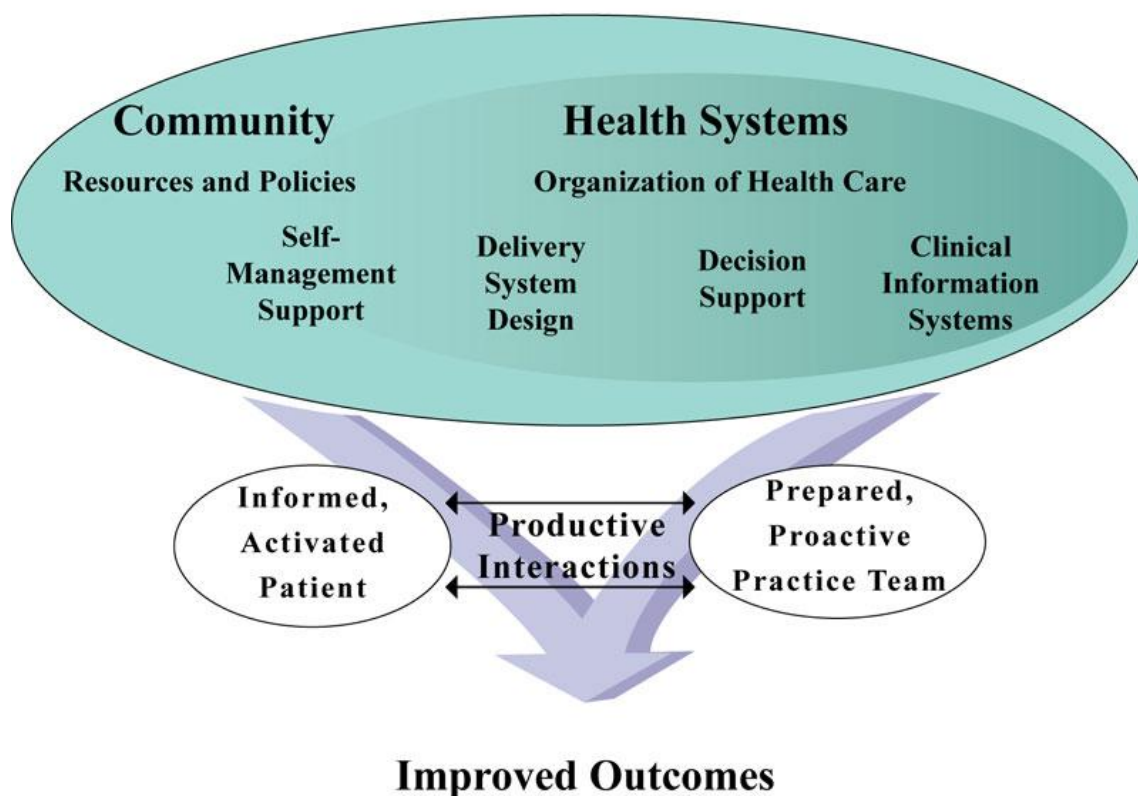
With nearly 2,200 citations, the CCM is "the best known and most influential" organizational model for chronic care (Pan American Health Organization (PAHO), 2013b), and has been "universally embraced as the guide for improving chronic care" (Bodenheimer & Willard-Grace, 2016, p. 89). It is considered the best synthesis of available evidence for CDM (Gammon et al., 2015) and is a widely adopted approach to ambulatory care improvement in the United States (Coleman, Austin, Brach, & Wagner, 2009). To improve the quality of chronic care in general, the use of the CCM has been

recommended by the Pan American Health Organization (i.e., regional WHO office for the Americas) (PAHO, 2013a). For diabetes care, the use of the CCM has been specifically recommended by the American Diabetes Association (American Diabetes Association (ADA), 2016) and Diabetes Canada (Clement et al., 2013). However, there is currently little research on implementing the CCM in Canada.

### **2.3.1 CCM Overview**

Following an extensive review of interventions to improve care for various chronically ill populations (Wagner et al., 1996), the CCM was developed in the late 1990s in the United States. The overall aim of the CCM is to develop well-informed, activated patients interacting with a practice team that is proactive and prepared for them with the end goal of improving outcomes (Bodenheimer & Wagner, 2002). In many countries, the CCM has informed policy for the care of patients with chronic disease, and has been adopted and adapted for use in different countries, such as the United Kingdom, Denmark, Russia, China, Australia, New Zealand, and Canada (Zwar et al., 2006).

## The Chronic Care Model



Developed by The MacColl Institute  
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**Figure 1 Chronic Care Model. Developed by The MacColl Institute, ©ACP-ASIM Journals and Books, Reprinted with permission from ACP-ASIM Journals and Books.**

The CCM posits that chronic care takes place in three overlapping domains: (1) the entire community (2) the health-care system; and (3) the provider organization (e.g., primary care practice) (Bodenheimer & Wagner, 2002). Within these domains, the CCM includes six elements that are inter-related and designed to strengthen the patient-provider relationship and improve health outcomes: (1) delivery systems design, (2) self-management support, (3) decision support, (4) clinical information systems, (5) the community, and (6) health systems. Specifically, four components of the CCM (i.e., decision support, delivery system design, clinical information systems, and self-

management support) are especially relevant to, and may help transform, primary care (Bodenheimer & Willard-Grace, 2016). In this way, the CCM facilitates a shift from acute to long term care. The specific components/elements of the CCM are outlined in Table 1.

**Table 1** Chronic Care Model Components (Based on Wagner et al., 2001)

<b>CCM Component</b>	<b>Description</b>	<b>Example</b>
Delivery System Design (DSD)	The structure of the medical practice to create teams with a clear division of labour and separating the acute from the planned care.	Planned visits and follow up are important features.
Self Management Support (SMS)	Collaboratively helping patients and their families to acquire the skills and confidence to manage their condition.	Provide self management tools, referrals to community resources, routinely assessing progress.
Decision Support (DS)	Integration of evidence based clinical guidelines into practice and reminder systems.	Guidelines reinforced by clinical “champions” providing education to other health professionals.
Clinical Information Systems (CIS)	Three important roles of computer information systems: Reminder system to improve compliance with guidelines, feedback on performance measures and registries for planning the care for chronic disease.	Advanced features of electronic medical records, such as registries.
Community Resources (CR)	Linkages with hospitals providing patient education classes or home care agencies.	Exercise programs, self help groups, and senior centres.
Health Care Organisation (HCO)	The structure, goals and values of the provider organisation.	The Health Care Organization's leadership, incentives, and improvement strategies.

Essentially, the six components of the CCM build upon each other. Delivery system redesign is critical to teaching self-management, as PCPs often do not have time for this activity (Bodenheimer & Willard-Grace, 2016). Similarly, redesigning delivery systems is necessary for the success of registries since at least one member of the primary care team should be responsible for working the registry. In addition, clinical practice

guidelines are a key decision-support tool that provide the evidence and basis for physician feedback data and reminder systems (Bodenheimer & Willard-Grace, 2016).

### **2.3.2 Evidence Supporting the CCM**

Numerous systematic reviews have been conducted on the CCM to evaluate its effects on the process measures and clinical outcomes for various chronic diseases, including diabetes. These systematic reviews generally recommend the use of multi-faceted, CCM-based interventions to improve chronic illness care, including chronic obstructive pulmonary disorder (COPD) (Adams et al., 2007), childhood obesity (Jacobson and Gance-Cleveland, 2010), and mental health (Williams et al., 2007; Woltmann et al., 2012). For diabetes care, Bodenheimer, Wagner, and Grumbach's (2002) systematic review found that 32 of 39 studies with interventions based on the CCM components had improved at least one process or outcome measure for diabetic patients. Stellefson, Dipnarine, and Stopka's (2013) systematic review revealed that the following components help to improve the coordination of diabetes care: use of organizational leaders, disease registries, electronic medical records, PCP training on how to deliver evidence-based care, and diabetes self-management education by PCPs. Although evidence was limited, several studies reported positive outcomes for the remaining CCM components (community resources and policies) (Stellefson, Dipnarine, & Stopka, 2013). Busetto et al. (2016) found that most interventions for type 2 diabetes included all CCM components and a variety of sub-components. Also, the review uncovered that most studies reported positive patient, process, and health service utilization measures (Busetto, Luijkx, Elissen, & Vrijhoef, 2016).

### **2.3.3 Application of the CCM**

Despite the evidence surrounding the effectiveness of the CCM, there is a dearth of research on implementing the CCM in Canada. For this research, the CCM will be used as a conceptual framework for designing an intervention to enhance PCP's use of advanced EMR features for diabetes care.

## **2.4 Electronic Medical Records**

According to the United States National Alliance for Health Information Technology (NAHIT), an electronic medical record (EMR) is used by authorized clinicians and staff within one health care organization, while an electronic health record (EHR) is an electronic patient record that meets nationally recognized interoperability standards and is used by authorized clinicians and staff in more than one health care organization (2008). In Canada, an EMR is a health record under the custodianship of PCPs (Hodge, 2011), whereas an EHR is used in secondary and tertiary care (hospital) settings. Due to the inter-changeable use of "EMR" and "EHR" by some authors in the American literature when referring to electronic medical records used in the primary care setting (Crosson, Ohman-Strickland, Cohen, Clark, & Crabtree, 2012), this research study uses the Canadian definition of EMR.

### **2.4.1 EMR Adoption and Use**

In 2001, the IOM had recommended the widespread adoption of EMRs to improve patient safety and health care quality. For over a decade, the adoption of EMRs had been a priority for Canada and the US, which lagged behind other developed countries, to improve health care quality and patient safety, reduce medical errors,

facilitate cost savings, enable greater patient engagement, and promote health system efficiency (Chaudhry et al., 2006; duPont, Koeninger, Guyer, & Travers, 2009; Finney Rutten et al., 2014; Price, Singer, & Kim, 2013). According to the 2015 Commonwealth Fund International Survey of PCPs in ten developed countries, EMR adoption has substantially increased over the last decade. Although Canada's EMR adoption rate is still lower than that of other developed countries, the 2014 (most recent) National Physician Survey (NPS) reveals that 77% of Canadian PCPs use an EMR. Further, nearly three quarters of these physicians have been using an EMR for over three years (NPS, 2014c).

#### **2.4.2 EMR Use for CDM**

With the help of EMRs, chronic diseases such as diabetes can be effectively and efficiently detected and managed in primary care. EMRs incorporate many elements of the CCM and provide significant potential to support diabetes care in a proactive, planned, and evidence-based way to improve process measures and health outcomes. In particular, EMRs are key to supporting practice-based population health management (PBPH) in primary care through: (1) identification of patients who need additional health care services, (2) creation of reminders or alerts to support PCPs in conducting follow-up tests, procedures, or education with patients, (3) sending of unique notifications based on clinical indicators, (4) graphical illustration of the impact of treatment or preventive manoeuvres on laboratory tests or other measured outcomes over time, and (5) displaying, exporting, and printing of data in different forms that can be used for further analysis (Vaghefi et al., 2016). As such, EMRs can make it easier for PCPs to develop, record, and track population and individual goals (targets) for patients with diabetes. At

the same time, EMRs can support patient self-management, decision support for PCPs (i.e., application and monitoring of evidence-based guidelines to improve health outcomes of patients with diabetes), and delivery system design through a proactive CDM appointment and reminder system.

### **2.4.3 The Effects of EMR Use on Process and Outcome Measures for Diabetes Care**

**Process measures** are used to "determine whether evidence-based care guidelines were followed" (Berenson, Pronovost, & Krumholz, 2013, p. 4). However, they do not indicate improvements in patient's health. Instead, process measures are used with the assumption that the use of evidence-based care processes will result in improved patient outcomes (Berenson et al., 2013). An example of a process measure is the percentage of patients with diabetes who have a blood pressure recorded in their chart in the last three months.

In contrast to process measures, **outcome measures** "seek to determine whether the desired results are achieved" (Berenson, Pronovost, & Krumholz, 2013, p. 4). An example of an outcome measure is whether a patient was re-admitted to the hospital within 30 days of discharge (Berenson et al., 2013). Intermediate or surrogate outcome measures (e.g., clinical indicators) may be used as proxies for patient outcomes (Berenson et al., 2013). For diabetes care, periodically measuring HbA1C is a process measure, whereas achieving a desirable HbA1C blood level is considered an intermediate outcome measure (Berenson et al., 2013). Outcome measures may also include various aspects of patient experiences, such as results from the Patient Reported Outcomes

Measures Information System and the Consumer Assessment of Healthcare Providers and Systems in the United States (Berenson et al., 2013).

There has been decades-old debate surrounding use of process measures vs. outcome measures (Bilimoria, 2015). In 2013, the Centers for Medicare & Medicaid Services (CMS) had committed to moving away from process measures (Berenson et al., 2013). However, it has recently been argued that "process measures should remain central in efforts to measure and improve care" (Bilimoria, 2015), as they support adherence to all best practice recommendations, are directly actionable, and offer important measurement benefits over outcome measures (Bilimoria, 2015). Process measures are also well-suited for individual clinician assessment and improvement efforts (Bilimoria, 2015). Baker and Chasin (2017) argue that outcome measures should only be used if they can be significantly influenced by physicians (i.e., there is a strong process-outcome link).

The concept of a strong process-outcome link aligns with Donabedian's Structure-Process-Outcome Model for health care quality (Donabedian, 2002). According to Donabedian's (2002) model, improvements in the structure of care (i.e., how a health care system is set up) should lead to improvements in clinical processes, which should in turn improve outcomes. However, Donabedian (2002) does recognize that this linear relationship is a simplified version of a more complex reality of causes and effects. Donabedian (2002) notes that process measures are "contemporaneous," as they take place in the "now" and provide immediate indications of quality. He describes the connection between process and outcome measures as "the problem of attribution," as the

outcome measures cannot be absolutely attributed to the process measure. However, Donabedian (2002) suggests that connections between process and outcome measures can be made with large sample populations, adjustments by case-mix, and long-term follow-up, as outcome measures can take considerable time to be observed. However, even with a large sample size, patients vary due to their medical, social, psychological, and genetic characteristics (Donabedian, 2002). As such, Donabedian's model has considerable implications for EMR use as a tool to facilitate process and outcome measures for care, especially for CDM.

As described in the next section, the EMR has significant potential to directly improve care processes and their measures (e.g., PCP's recording and tracking of a blood pressure in the EMR) for chronic diseases. However, this does not necessarily suggest that the EMR directly influences outcomes for chronic diseases, including intermediate or surrogate measures. It is important to note that the relationship between health care processes and patient outcomes is complex and likely non-linear. As Donabedian (2002) suggests, improvements in process measures do not necessarily result in improved patient outcomes, as there may be many potential intervening variables and vice versa. This may explain the mixed effects of EMRs on care quality that are currently found in the literature.

Recent systematic reviews have found inconclusive or mixed effects of EMRs on process and outcome measures. As an example, Lau et al.'s (2012) systematic review found that there is a 51% chance that an EMR can improve office practice, a 30% chance that there will not be any effect, and a 19% likelihood that it may lead to negative

outcomes. Further, the systematic review found less improvement in CDM, patient record quality, and decision support tools as compared to earlier reviews; Lau et al. (2012) found similar improvement in preventative care. Holroyd-Leduc et al.'s (2011) systematic review found that although EMRs have structural (e.g., legibility, accessibility) and process measure benefits, the influence on outcome measures is less clear. Although many PCPs perceive a positive effect of the EMR on quality of care, the effects of the EMR on quality indicators appear to be mixed (Holroyd-Leduc, Lorenzetti, Straus, Sykes, & Quan, 2011). Another systematic review and meta-analysis of the of the EHR literature by Campanella et al. (2016) reveals that EHRs can improve the quality of health care by increasing time efficiency, increasing guideline adherence, and reducing medication errors and adverse drug events (Campanella et al., 2016).

Research on the effects of EMR on process and outcome measures for diabetes care is also inconclusive. Some studies have reported improvements in: (1) process and outcome measures (Love et al., 2008; Reed et al., 2012); (2) process measures but no improvements in outcome measures (Meigs et al., 2003; Montori et al., 2002; O'Connor et al., 2005; Sperl-Hillen & O'Connor, 2005); and (3) outcome measures alone (Nease & Green, 2003). Some researchers have also found negative effects of EMR on process measures for diabetes care (Crosson et al., 2007). Given these mixed effects, it is difficult to propose a linear relationship of causation between the effects of EMRs on process measures and outcome measures for diabetes care.

To align with Donabedian's Structure-Process-Outcome Model and current literature on the effects of EMR on process and outcome measures for CDM and diabetes care specifically, this research study proposes that process and outcome measures for

diabetes care can be partially attributed to the use of the CCM (and inherent use of the EMR). This hypothesized relationship is also based on a Cochrane review on diabetes interventions in the primary care, outpatient, and community settings (Renders et al., 2001). The lead author of the CCM (Edward H. Wagner) was also involved in the review as a researcher. The Cochrane review revealed that successful interventions were typically multifaceted and comprehensive (Renders et al., 2001). Specifically, it concluded that a successful intervention should include one or more of the following components: “provider-oriented components such as continuing education or physician feedback, organizational changes in personnel or the management of visits and follow-up, information systems changes, and patient-oriented interventions of an educational or supportive nature” (Renders et al., 2001, pp. 66-67). All of these components align with the CCM. These CCM-based interventions were found to generally improve process measures for diabetes care. In particular, "combinations of various forms of provider education, computerized tracking and reminder systems, and organized approaches to follow-up achieved the greatest success in improving process indicators such as foot and eye exams" (Wagner et al., 2001, p. 67). The review also found that including patient-oriented interventions (e.g., patient education) can lead to improved patient health outcomes. Given the positive empirical findings surrounding the effects of the CCM-based interventions on process and outcome measures for diabetes care, this research proposes that the use of EMR will (1) fully affect process measures for diabetes care and (2) partially affect outcome measures for diabetes care.

#### **2.4.4 Current State of EMR Use for CDM**

Research shows that the main benefits associated with EMRs are preventive care and CDM (Adaji, Schattner, & Jones, 2008; Baer, Cho, Walmer, Bain, & Bates, 2013; Black et al., 2011; Buntin, Burke, Hoaglin, & Blumenthal, 2011; Canada Health Infoway, 2013; Chaudhry et al., 2006; Delpierre et al., 2004; Jones et al., 2014; Lau et al., 2012; Lau, Kuziemy, Price, & Gardner, 2010; Smith, Skow, Bodurtha, & Kinra, 2013; Vaghefi et al., 2016). This research is mostly from organizations that are advanced in their EMR implementation. In other organizations, and specifically PCP offices, there is room for improvement in use of the EMR for preventative care and CDM.

The 2015 Commonwealth Fund survey reports variable and overall limited use of EMRs for CDM in ten developed countries, such as the use of recalls. According to a 2013 report by Canada Health Infoway, only 3% of Canadian PCPs who use EMRs have realized improvements in process measures (e.g., recording a blood pressure in the EMR) for CDM or preventive care. Canadian PCPs have been found to use their EMRs as “electronic paper records” and only use the minimal or basic EMR features (Price et al., 2013). In fact, the majority of PCPs do not fully adopt advanced features (e.g., use of registries for CDM, running wait-time or cycle time reports, etc.) even two years following implementation (Denomme et al., 2011; Loomis, Ries, Saywell, & Thakker, 2002; Price et al., 2013). This can lead to personal dissatisfaction, low self-efficacy, time loss, and reduced productivity for physicians (Loomis et al., 2002), as well as reduced quality and safety of care for patients (Finney Rutten et al., 2014).

The use of advanced EMR features also closely aligns with the components of the CCM. Specifically, the EMR can support the delivery system design, self-management support, decision support, and clinical information systems components of the CCM. In this way, the CCM and EMR provide the "Structure" (i.e., delivery system design) and "Process" (i.e., self-management support, decision support, and clinical information systems) components of Donabedian's (2002) Structure-Process-Outcome Model for clinical practice.

To support **delivery system design**, reminding patients about planned visits and follow up care is key. Except for New Zealand and the UK, PCPs' routine use of computerized systems to send reminders to patients when it is time for regular preventive or follow-up care is low. Countries with the lowest reported rates included Norway (9%), Switzerland (14%), France (17%), Canada (18%), and the US (40%) (Commonwealth Fund, 2015).

In terms of **self-management support**, about half of the PCPs in the UK (52%) and USA (46%) reported providing written instructions to patients about how to manage their own care at home (i.e., self-management), while only 18% of Canadian PCPs reported doing so (Commonwealth Fund, 2015). These rates are even lower in Norway (14%) and Sweden (10%). Similarly, about half of the PCPs in Australia (47%), the Netherlands (54%), and the UK (55%) reported routinely recording their patients' self-management goals in their EMR, whereas only about a third of PCPs in Canada (32%), France (35%), New Zealand (32%), Switzerland (32%), and the USA (36%) reported this

(Commonwealth Fund, 2015). In Norway, only 11% of PCPs reported routinely recording their patients' self-management goals (Commonwealth Fund, 2015).

Creating patient registries for chronic diseases is central to the **clinical information systems** component of the CCM. Most physicians responding to the 2015 Commonwealth Fund survey reported that they could generate a list of patients by diagnosis (i.e., create a registry). Countries with the lowest percentage of physicians reporting the ability to generate this list were Switzerland (32%), France (51%), and Canada (63%), while the highest percentages reported were in UK (99%), New Zealand (99%), and the Netherlands (98%) (Commonwealth Fund, 2015). However, only about half (48%) of Canadian PCPs and two-thirds of American PCPs (65%) reported being able to generate a list of patients who are due or overdue for tests or preventive care (i.e., run a complex report) (Commonwealth Fund, 2015). This rate was reported to be even lower in Norway (16%), Switzerland (29%), Sweden (37%), and France (39%) (Commonwealth Fund, 2015). It is important to note that the UK, New Zealand, and the Netherlands are also among the countries with the highest EMR adoption rates in the world.

Having a reminder system to improve compliance with guidelines is an important aspect of clinical information systems component, as well as the **decision support** component. Among countries surveyed by the Commonwealth Fund, the percentage of PCPs receiving reminders for guideline-based interventions and/or screening tests is relatively low, with the highest percentages reported in the UK (77%), New Zealand (61%), and Australia (56%), and the lowest percentages reported in Sweden (7%),

Switzerland (9%), Norway (10%), Germany (15%), Canada (26%), and the USA (47%) (Commonwealth Fund, 2015).

In terms of reviewing clinical outcomes for patients (e.g., percentage of patients with diabetes with good control), only 9% of Swedish PCPs and about a quarter (23%) of Canadian PCPs reported doing so. About a third of Norwegian (32%) and Australian (35%) PCPs and half of American PCPs (52%) indicated that they reviewed clinical outcomes for patients, while the majority of Dutch (88%), British (86%), and Swedish (79%) reported doing so. These gaps in the use of the EMR for CDM suggest that many PCPs around the world are not using their EMRs to their full potential. The next section describes the terminology used in the United States and Canada to describe maturity of EMR use.

#### **2.4.5 Value-Adding, Extended, and Meaningful EMR Use**

In the field of information systems, "value-adding use" or "extended use" are two terms used to describe enhanced information system use. Value-adding use "is volitional and must be conducted to achieve a specific value-adding objective" (McClean, Sedera, & Tan, 2011, p. 6). It includes additional use (i.e., non-core, non-automated, and/or non-compulsory) use by the user to increase output or impact (McClean et al., 2011).

Similarly, extended use is "the use behaviour that goes beyond typical usage and can potentially lead to better results and returns" (Hsieh & Wang, 2007, p. 217). Raymond et al. (2015) have proposed to apply this concept to EMRs through "extended EMR Use."

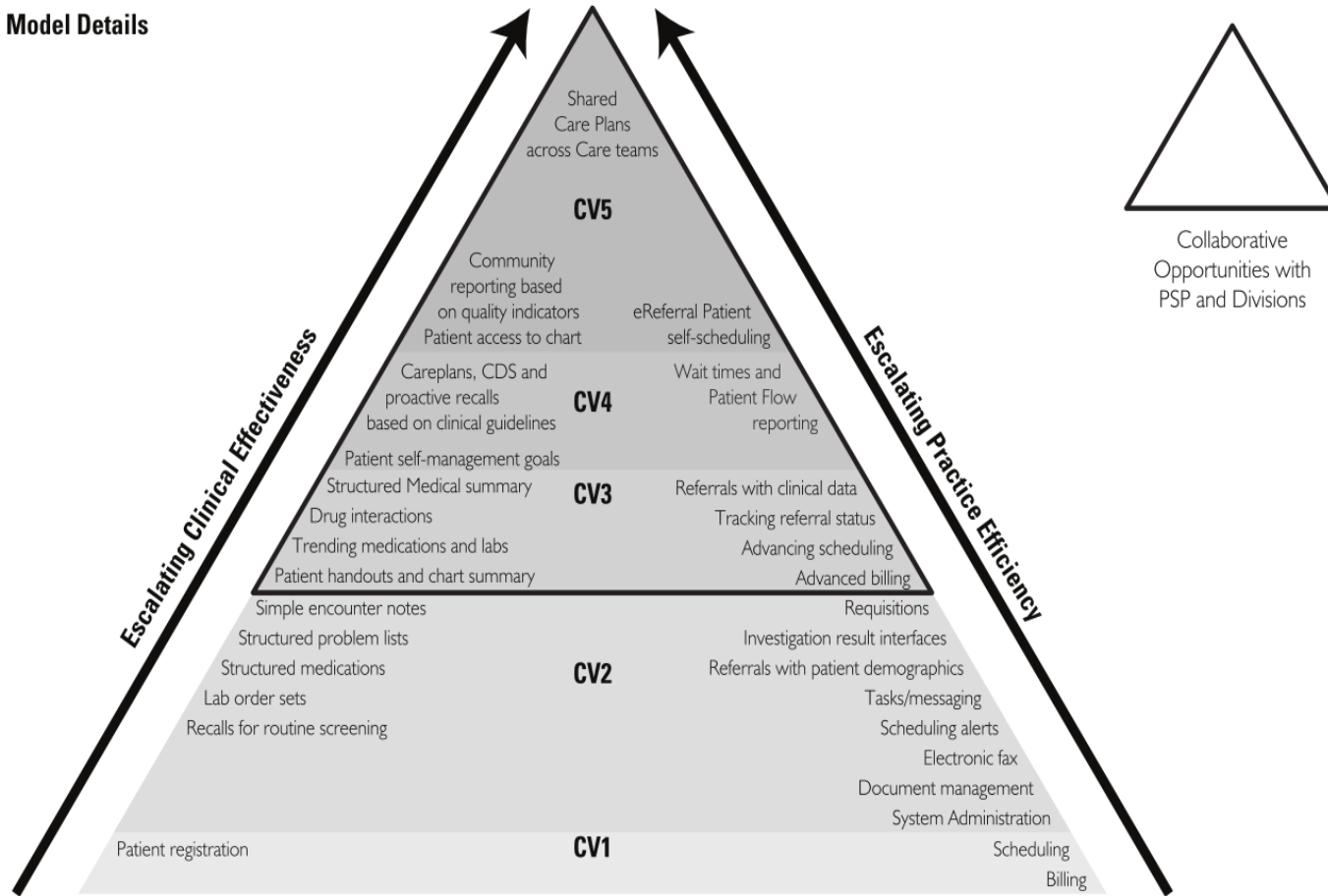
Meaningful use (MU) is a term that is often referred to in the EHR literature. MU was developed by legislation in the United States as a part of the American Recovery and Reinvestment Act (ARRA), following the economic crisis of 2008. The main motivation of MU was to improve health care and boost the economy through a dedicated industry of health information technology. MU sets specific objectives that health care professionals and hospitals must meet to receive financial incentives for adopting and using EHRs (Rimmer, Hagens, Baldwin, & Anderson, 2014), with the goal of achieving better care and improved population health at a lower cost (Heisey-Grove, Danehy, Consolazio, Lynch, & Mostashari, 2014). Specifically, MU was broken down into three stages to enable health care professionals to progress and mature their use of EHR features and standards (Heisey-Grove et al., 2014). The three stages included (1) data capture and sharing, (2) advanced clinical processes, and (3) improved outcomes (Center for Disease Control, 2017). Although the MU program has resulted in high EHR adoption in the United States (Halamka & Tripathi, 2017), it has caused many negative, unintended consequences, such as decreased face-to-face time with patients, increased documentation of low-value administrative data, and increased physician dissatisfaction and burnout (Downing, Bates, & Longhurst, 2018; Halamka & Tripathi, 2017). In 2018, the MU Program was transitioned to become one of the four components of a new Merit-Based Incentive Payment System (MIPS), which is a part of the new Medicare Access and CHIP Reauthorization Act (MACRA) (HealthIT.gov, n.d.).

In Canada, MU has been used to refer to more mature use of EMRs. Extended or value-adding EMR use is more often referred to as "clinical value," "benefits realization," and "maturity of use." This includes richer functionality, more complete and structured

data, and redesign of clinical and administrative processes to increase the efficiency and effectiveness of clinicians (Rimmer et al., 2014).

In BC, MU or clinical value can be assessed using the "Clinical Value Model" developed by the Physician Information Technology Office (PITO) (Rimmer et al., 2014). The model is illustrated in Figure 2 below. It references existing MU models in Canada and the United States, and was tested by 250 physicians and clinic staff in BC (Practice Support Program - Technology Group, 2014b). The model depicts five levels of clinical value (CV), from very basic to advanced use.

**GP Clinical Value Model Details**



**Figure 2 Clinical Value Model. From “Measuring Maturity of Use for Electronic Medical Records (EMRs) in British Columbia: The Physician Information Technology Office (PITO),” by C. Rimmer, S. Hagens, A. Baldwin, and C.J. Anderson, 2014, Healthcare Quarterly, p. 77. Reprinted with permission.**

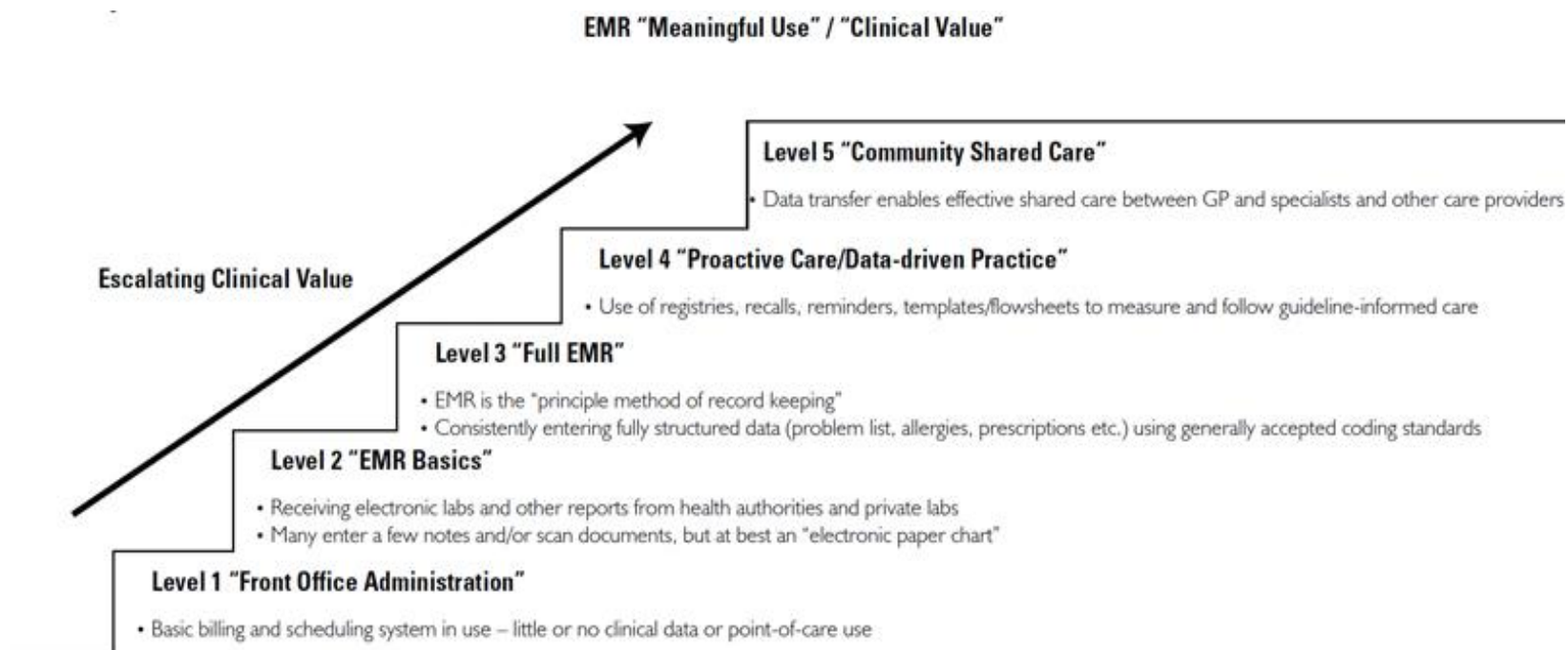
The first level of CV (**Level 1**) is the most basic use of the EMR and includes patient registration, scheduling, and billing functions. **Level 2** includes additional use of the EMR for notes and scanning of documents. Although this level includes the electronic receipt of labs and other reports from health authorities and private labs, PCPs at this level are using the EMR as an "electronic paper chart" (i.e., the electronic patient chart is a replication of what the PCPs would record on a paper chart, such as free-text notes).

In **Level 3** (considered "baseline" level of maturity), the PCP uses the EMR to create structured medical summaries, record drug interactions, medications and lab results, create patient handouts and chart summaries, create and track referrals, and conduct advanced scheduling and billing (Rimmer et al., 2014).

**Level 4** includes use of the EMR for proactive care/data driven practice and includes use of registries (i.e., lists of patients with a certain condition whose care can be tracked using process measures, clinical indicators, etc.), reminders (i.e., EMR messages directed at PCPs and/or their staff), and templates/flowsheets (i.e., short forms that gather all the important data regarding a patient's condition) to measure and follow guideline-informed care for CDM.

PCPs at **Level 5** have the highest level of use with the development and sharing of integrated care plans across the patient's care team. At Level 5, patients also have online access to scheduling and their patient record, as well as the ability to request referrals or consults with practice clinicians about a health matter or concern (Rimmer et al., 2014).

The steps to achieving MU/clinical value are illustrated in Figure 3 below.



**Figure 3 Steps to Achieving Meaningful Use.** From “Measuring Maturity of Use for Electronic Medical Records (EMRs) in British Columbia: The Physician Information Technology Office (PITO),” by C. Rimmer, S. Hagens, A. Baldwin, and C.J. Anderson, 2014, *Healthcare Quarterly*, p. 77. Reprinted with permission.

Although 85% of Canadian PCPs manage chronic diseases in their practice (National Physician Survey, 2014a), there is variation in practice and room for improvement in chronic disease monitoring in the primary care setting (CIHI, 2014). PCPs could make better use of advanced EMR functionality to prevent and manage chronic diseases (i.e., achieve MU Level 4).

In 2005, BC had set a ten-year goal of having the majority of PCPs managing chronic disease aided by EMRs that allowed for the identification of patients with certain conditions and employed “system messages and flags to initiate regular tests and planned visits, based on clinical best practices and evidence-based guidelines” (British Columbia eHealth Steering Committee, 2005, p. 23). At that time, only 9% of PCPs used an EMR and of these PCPs, only one-fifth used their EMR for CDM (British Columbia eHealth Steering Committee, 2005). Nearly 10 years later, use of the EMR for CDM had increased. In 2014, 82% of Canadian PCPs reported using their EMR to manage their patients' chronic conditions (National Physician Survey (NPS), 2014b). However, Canada Health Infoway (2013) estimates that only 3-18% of Canadian PCPs have realized improvements in process measures for CDM or preventive care, such as the identification of patients who are at-risk or in need of follow-up.

#### **2.4.6 EMR Use for Diabetes Care**

The EMR has significant potential to support and streamline diabetes care. Specifically, the EMR can help (1) identify patients with diabetes, (2) assess whether a patient is due for recommended tests or screening procedures, and (3) determine which

patients have not achieved evidence-based clinical goals for key measures (i.e., glycemic, lipid, and blood pressure control) (O'Connor et al., 2005). Typically, the EMR presents this information to PCPs as reminders (i.e., patient is due for a Hemoglobin A1C test) or prompts (patient's Hemoglobin A1C is above recommended level) at the point of care, as well as in the form of periodic reports (e.g., all diabetic patients who have not had an eye exam in the last 24 months). However, current diabetes care is affected by high rates of clinical inertia (i.e., failure to intensify treatment for patients who do not achieve evidence-based goals), which affects nearly half of all diabetic patients. EMRs can reduce clinical inertia and improve patient care (O'Connor et al., 2005).

Data from the Canadian Institute for Health Information (CIHI) also reveals significant gaps and opportunity for improvement in diabetes care documentation and management using the EMR for PCPs (2014). For example, although Canadian clinical practice guidelines recommend blood glucose control (Hemoglobin A1C) testing for most patients every three months, a CIHI study found that only a third of practices had a Hemoglobin A1C test recorded in their EMR for at least 90% of their patients with diabetes in the last 15 months (CIHI, 2014). It is unclear if this was a diabetes care process measure issue, or a data quality issue (i.e., patient data is not documented, documented in a way that is difficult to read, or documented in the wrong section of the EMR, etc.). For patients who had test results available, only half had a Hemoglobin A1C in the desired range (CIHI, 2014). A recent Australian study also found similar gaps in diabetes care using the EMR (Swerissen et al., 2016). It was reported that only 15% of patients with diabetes had recorded values for Hemoglobin A1C, body mass index, and

blood pressure, and of the patients whose measurements were recorded, only 20% had achieved the recommended targets (Swerissen et al., 2016).

These findings highlight the missed opportunity in chronic disease monitoring for PCPs to use advanced EMR features (i.e., registries, templates, reminders, etc.) (CIHI, 2014). At the same time, this previous research demonstrates the need to support PCPs in the advanced use of their EMRs for diabetes care and EMR documentation. Training and support to enable maturity of EMR use has been identified as a national research priority (Canada Health Infoway, 2013). Additionally, Canada Health Infoway (2013) has recommended further quantitative research on the effect of EMRs on health outcomes, as well as research on the capacity of clinicians for pursuing continuing education to learn how to use their EMR to assess the needs of their patient populations. This reveals the opportunity and critical need to examine how to support PCPs in their use of the advanced features of their EMRs for diabetes care.

#### **2.4.6 Supporting EMR Adoption and Use in BC**

Physician Information Technology Office (PITO) is an organization that was formed in 2006 by the BC Medical Association (BCMA) (now Doctors of BC) and the BC provincial government to support the pre-implementation, implementation, post-implementation, and optimization of EMRs in physician offices across BC (PITO, 2013). The purpose of PITO was to facilitate the adoption of technology, especially EMRs, through the disbursement of IT reimbursement funds (PITO, 2013). In 2014, the mandate of PITO was fulfilled, as nearly all PCPs in BC had adopted an EMR. As a result, PITO was replaced in 2014 with a new organization called the Practice Support Program-

Technology Group (PSP-TG, 2014a). The objective of PSP-TG was to provide post-implementation support, peer support, and technical support to physicians in BC (PSP-TG, 2014a) who are using EMRs. Specifically, the PSP-TG was mandated to ensure the achievement of MU Level 3 (i.e., baseline maturity) by PCPs in BC. To achieve this, the PSP-TG first conducted MU assessments of PCPs and then developed and delivered the necessary post-implementation supports (e.g., peer mentoring support, user groups, etc.) to increase MU levels for PCPs.

In 2015, the work of the PSP-TG was taken on by the BC Practice Support Program (PSP) (General Practice Services Committee, 2015). The PSP is a joint initiative of the Government of BC and Doctors of BC (formerly the BCMA) (Practice Support Program, 2015). The PSP is a quality improvement program that provides in-practice coaching and CME-accredited (continuing medical education) learning modules for improving clinical and practice management. The PSP has been responsible for "EMR optimization" to support quality improvement work and "demonstrate measurable progress and impact" (Practice Support Program, 2015). From July 2015 to March 2016, the PSP had introduced small group learning sessions (SGLS), a new format for providing EUS to PCPs to support their EMR optimization. The SGLS was a learning/training session that included 2-50 PCPs and focused on a topic related to EMR optimization. SGLS also covered topics related to clinical quality improvement, office efficiency, advanced access, and clinical workflow improvements. Participation in SGLS was funded and accredited for PCPs, and may have included in-office support between sessions. In April 2016, the SGLS format for EMR optimization was discontinued. The PSP then introduced EMR-enabled tools to improve the identification of patients with

chronic pain, adult mental health, child and youth mental health, heart failure, and COPD. From 2016-2017, PSP conducted a panel assessment pilot project for Intrahealth, Med Access, Wolf and Osler EMRs, in which participating physicians learned to more effectively use their EMRs and to better understand their patient populations. Since 2016, EMR peer mentoring has also been available to PCPs through the PSP Peer Support Network.

## 2.5 IT Training Interventions

**Training** refers to learning that is provided to improve performance on the present job, whereas **education** provides learning to improve performance on a future job (Nadler, 1984). For information systems, the purpose of training is to provide end-users with "the conceptual and procedural knowledge necessary to put the technology to effective use" (Venkatesh et al., 1999, p. 3). Since the 1980's, research has emphasized the importance of communicating knowledge to users through IT training (Davis & Bostrom, 1993; Eason, 1982; Kalen & Allwood, 1991; Rockart & Flannery, 1983; Webster & Martocchio, 1995). Numerous studies have highlighted the need for basic and advanced training for any strategy designed to enhance end-users' efficiency and effectiveness with using IT (Brancheau, Janz, & Wetherbe, 1987; Cheney, Mann, & Amoroso, 1986; Rivard & Huff, 1988; Sein, 1987; White & Christy, 1987). More recently, training has been suggested as a critical post-implementation intervention to increase user acceptance and system success (Sharma & Yetton, 2007).

The literature on educational interventions for information systems identifies seven methods of software training: (1) tutorial; (2) course/lecture/seminar; (3) computer-

aided instruction; (4) interactive training manual; (5) resident expert; (6) help component; and (7) external training (Nelson & Cheney, 1987). In terms of the "support source," other research describes three methods of IT training: online, document-based, and instruction-based (Czaja, Hammond, Blascovich, & Swede, 1986). More recently, video tutorials have been introduced as a new type of tutorial (see Section 2.7). Specific educational interventions for EHR/EMR training are discussed below.

## **2.6 EHR/EMR Training Interventions**

For EMRs and EHRs, training is intended to prepare end-users to use the EMR or EHR in real clinical practice (Goveia et al., 2013). Proper training and support is central to system implementation (Lemmetty, Häyrynen, & Sundgren, 2009; Youssef, 2013). Training is a communication tool that drives technology implementation to help end-users understand the benefits and disadvantages of system, as well as increase their adoption, satisfaction, and use of the technology (Youssef, 2013). As such, training is a continuous, ongoing process (Youssef, 2013). Failure to continuously educate causes individuals to fall behind with resultant problems in system use and practice productivity (Lorenzi, Kouroubali, Detmer, & Bloomrosen, 2009), such as lack of feature use (Puffer et al., 2007). EHR/EMR training may be provided pre- or post-implementation or both.

### **2.6.1 Pre-Implementation EHR/EMR Training**

Pre-implementation training is the first phase of educating staff about the concept of the EHR, system features, as well as the rationale for adoption (Cascardo, 2007; Crosson et al., 2011; Kirshner, Salomon, & Chin, 2004). Strategically providing pre-implementation training to end-users is critical (Agnò & Guo, 2013) to achieving user

acceptance (Lemmetty et al., 2009). Providing early orientation and demonstration of the system to end-users can help increase comfort with basic functions of the system (Smith, 2013) and increase motivation for using the EMR (Denomme et al., 2011). On the other hand, training may sometimes lower acceptance as it helps users form realistic expectations of information systems and the effort involved in learning to use them (Shachak and Fine, 2008). It may also help practice staff to become familiar with the EHR menus and workflow (Hess, 2011). One study recommended training non-clinical staff and nurses before physicians (Cascardo, 2007) so they can become familiar with the system and then assist physicians with learning how to use it (Krall, 1995). McAlearney et al. (2012) recommend that pre-implementation training be conducted on-site. For larger scale implementations, it has been recommended that training be provided 2-8 weeks before go-live (Pantaleoni, Stevens, Mailes, Goad, & Longhurst, 2015). In addition, no training should occur 1-2 weeks before go-live to ensure it is not provided at the last moment (Pantaleoni et al., 2015). Further, extensive support should be provided at and immediately after go-live to support users' needs to access knowledgeable resources and enable continued learning in practice (Fenton, Giannangelo, & Stanfill, 2006; McAlearney, Robbins, Kowalczyk, Chisolm, & Song, 2012), such as through a telephone help line. In one study, learning sessions were provided to orient users to the system (Janols, Lind, Göransson, & Sandblad, 2014).

In another study, pre-implementation training started with an initial phone call with the vendor, followed by two training sessions at the practice site that cover basic, special, and advanced functions (Shachak et al., 2013). The length of the sessions and

amount of coverage should be carefully considered, as this has been found to be a source for end-user complaints (Stromberg, 2011).

### **2.6.2 Post-Implementation EHR/EMR Training**

Pre-implementation training is necessary but not sufficient (Hill, Stewart, & Ash, 2010; Puffer et al., 2007). Hence, post-implementation is often a necessary ongoing effort (Puffer et al., 2007), which has been found to increase MU (e.g., increased use of medication lists and problem lists) (Bredfeldt et al., 2013). Post-implementation training may be provided on request (e.g., to train new staff) or after major system upgrades (Shachak et al., 2013). It can also be provided to help increase value-adding or extended EMR use. In some cases, end-users have requested for post-implementation EHR training and personal counseling or coaching on how to use the system (Lau, Partridge, Randhawa, & Bowen, 2013; Lemmetty et al., 2009).

Peck (2013) recommends that physician practices make a long-term commitment to EHR training. It has also been recommended that post-implementation training be provided incrementally over time to increase meaningful use using a multi-faceted training strategy (Lau et al., 2013). Further, regular training should be scheduled as a part of users' regular work schedule to address "what's working, what's not, and why" (Sorensen, 2013).

### **2.6.3 Training Methods**

To date, EHR/EMR training has been provided in various formats. A scoping review by Younge et al. (2015) identified seven types of EHR training methods:

traditional instructor-led classroom training, one-on-one training, familiarization, computer-based training (CBT), blended learning, feedback, and support. "Support" may not be considered a training method, as it is provided in the "moment of need" (Schaefer, 2015). All of these methods have different benefits and limitations. For example, classroom training and blended learning have helped to address end-user needs (McCain, 2008). Similarly, hospitals have reported the significant benefit of having trainers shadow end-users to allow questions to be answered "on the spot, anytime, anywhere" (DeVore & Figlioli, 2010). This allows learning to happen on-the-job (OTJ), which increases end-user comfort with the system and the likelihood of realizing benefits early (DeVore & Figlioli, 2010). It is unclear which single training method is the preferred method of training, as health care professionals generally receive a number of training methods (Younge, Borycki, & Kushniruk, 2015). It appears that training is more effective when a combination of training methods are used (Younge et al., 2015). In fact, some authors suggest that there is a need for various strategies and methods for EHR training to meet individual learner needs (Kamath, Storlie, & Ferguson, 2006; Koo & Ph, 2004). Use of multi-faceted educational interventions has also been found to increase meaningful use (Goveia et al., 2013). For example, some studies have examined a blended learning format (Goveia et al., 2013; Youssef, 2013) with short lectures and demonstrations, hands-on activities (Bredfeldt et al., 2013), and online and in-class training followed by one-to-one training during the pre- and post-implementation (Fenton et al., 2006). One study provided introductory training online followed by mandatory didactic training in the classroom (Birk, 2010). Similarly, this type of classroom teaching and training

independently in one's own environment has been found to sustain learning of the system (Lemmetty et al., 2009).

In addition to the location of training, the timing and length of training is an important consideration (Jalota, Aryal, Mahmood, Wasser, & Donato, 2014); it should carefully be considered in designing training interventions (McAlearney et al., 2012; Stromberg, 2011), as time pressures impact both EHR training and implementation sessions (Gamm et al., 1998). Given that high patient workload leaves little time for training, some physicians learn new EHR functions on the weekends, while others express reluctance to including additional duties in their busy schedules (Goetz, 2012). Taking time away during office hours for training is often cited as a concern due to its negative implications for patient time and revenue opportunities (Haugen, 2012). As a result, some physicians have indicated a preference for receiving training after office hours (Goveia et al., 2013). In one Canadian study, it was recommended that training should be provided during paid or protected time during the day when physicians are less fatigued (Randhawa, 2013). In some cases, computer-based training has been implemented for end-users to complete the EHR training at their own pace at a time and location that is convenient to them (Goveia et al., 2013). Consequently, the selection of an EHR training format that addresses these concerns is of critical importance. As described below, video tutorials may provide a good solution for post-implementation EHR/EMR training as a self-paced, accessible, convenient, sustainable, and effective format.

## 2.7 Video Tutorials

Video tutorials (which often employ "screencasts"- a technology to record a computer screen output, showing actions and changes of the screen as seen by the user) are a type of training intervention that emerged in the early 1990's (Palaigeorgiou & Despotakis, 2010). Essentially, video tutorials are video demonstrations of how to accomplish tasks using software (Baecker, 2002). Unlike other multimedia resources, video tutorials are a simple, affordable tool to produce authentic, situated, and motivational instructional material that can be used in various education settings (e.g., self-paced learning) (Palaigeorgiou & Despotakis, 2010). As a transparent demonstration tool, video tutorials show how objects are manipulated on the user interface, including their transitions, transformations, timing information, focus orientation, and mouse movements (Palaigeorgiou & Despotakis, 2010).

The benefits of video tutorials include the development of a better mental model of human-interface interactions (Papademetriou et al., 2015), faster initial learning and better comfort than using static versions of instructions, as well as increased control and autonomy (Palaigeorgiou & Despotakis, 2010). Grossman and Fitzmaurice (2010) also found that integrating narrated video clips into software can help to overcome software learnability difficulties. However, there are also a number of limitations of using video tutorials. The "mimicry model" (i.e., memorizing and copying steps without internalizing the task) that underpins video tutorials can reduce retention and transfer of skills (Harrison, 1995; Palmiter & Elkerton, 1991). For this reason, the effectiveness of video tutorials is questionable (Despotakis et al., 2007). Other reported challenges with video tutorials include distraction of users from concentrating on key issues (Despotakis et al.,

2007), undermined learning outcomes due to less activated and engaged learners (Ertelt, 2007; Palmiter & Elkerton, 1991), reduced control of the learning pace (Ertelt, 2007), and fundamental usability flaws (Despotakis et al., 2007).

Despite these challenges, video tutorials can reduce cognitive processing and allow users to immediately practice the skills they have acquired, which is especially suitable for novices (Palaigeorgiou & Despotakis, 2010). In the context of training novices such as medical residents and nursing students on EMRs, video tutorials have recently been used (He, Marquard, & Henneman, 2016; Thiyagarajan, Allen, Peacock, & Cousins, 2017; Zoghbi et al., 2017). However, to the knowledge of the author, primary research studies on the use of video tutorials for EHR/EMR training of PCPs or other physicians have not been published to date.

As a part of a large EHR training program for nursing students, He et al. (2016) had included two video tutorials: one 15 minute video tutorial that provided a procedural demonstration of EHR functions and another three-minute video tutorial that provided conceptual information on how to integrate the EHR functions into the clinical process. The first video tutorial included time for the users to practice the functions introduced in the EHR, while the second video tutorial involved a paper-based exercise to complete after watching the video tutorial. From their iterative training design and testing, the authors identified several changes to improve their video tutorials: (1) introduce two EHR functions at a time, followed by hands-on practice, (2) add review questions about the video tutorial content introduced and provide answers, (3) ensure video tutorials are

relevant to clinical care, and (4) provide video tutorials in addition to paper tutorials (He et al., 2016).

Recently, Thiyagarajan et al. (2017) published their study on the use of EHR video tutorials to orient medical student clinicians to the EHR in a student-run clinic. The purpose of their research was to assess if there was any increase in EHR utilization since the implementation of the EHR video tutorials. The study intervention included three video tutorials on how to find patients in the EHR, how to find and complete SOAP notes, and one video tutorial on miscellaneous items, such as how to find scanned documents. The online video tutorials ranged from 53 seconds to two minutes and 29 seconds in length. The authors' retrospective chart review revealed that there was a significant improvement in completion of the past medical history field (45% pre-intervention to 72% post-intervention) and the smoking status field (55% pre-intervention to 77% post-intervention) (Thiyagarajan et al., 2017). Additionally, the use of three EHR functions post-intervention also approached significance: Attending Signature, Social History, and Screenings (Thiyagarajan et al., 2017). Although the study demonstrated that use of EHR capabilities by student clinics had improved since the development of the video tutorials, a major limitation of the study was the inability to link the post-implementation charts with student clinicians who had watched the video tutorials (Thiyagarajan et al., 2017). As a result, it was difficult for the authors to determine if the observed changes in charting were related to the intervention. However, the authors received informal positive feedback about the video tutorials. They also reported that the video tutorials helped to decrease the amount of time needed for EHR staff to orient student clinicians to the EHR (Thiyagarajan et al., 2017).

Using a mixed methods approach, Zoghbi et al. (2017) conducted a pre-post study to examine the effects of video tutorials on EMR use for a group of general surgery residents. The video tutorials all presented procedural "how to" information on seven EMR tasks: checking vital signs, booking an Operating Room (OR) case, placing pre-procedure orders, ordering negative-pressure wound therapy supplies, updating day-of-surgery history and physical notes, writing brief operative notes, and discharging patients from the Post-Anesthesia Care Unit (Zoghbi et al., 2017). All video tutorials were less than three minutes in duration. The study found statistically significant effects of the video tutorials in increasing residents' confidence in carrying out EMR tasks, increasing their clinical scores on emergency simulations, as well as decreasing their time required to perform essential EMR tasks without the video tutorial training (Zoghbi et al., 2017).

The use of video tutorials in the studies by Thiagarajan et al. (2017) and Zoghbi et al. (2017) demonstrates the potential of video tutorials for increasing EMR use for diabetes care, and aligns with the intervention in this dissertation research study. Given physicians' positive attitudes towards online CME (with reported benefits including accessibility, time-savings, and serving physician needs) (Albarrak, Alsughayr, & Alzawawi, 2009), video tutorials are an appropriate medium for the EMR training intervention in this proposed research. Further, this type of self-directed learning or delivery mode for CME has been found to be the most effective approach for improving physician performance (Mamary & Charles, 2003). Finally, video tutorials are well-suited to novice EMR users to provide training on advanced EMR features. For these reasons, video tutorials provide a suitable intervention for this dissertation research, as

the need to evaluate and improve physician performance in EMR use is a research gap and further discussed in the next chapter.

## 2.8 Training Evaluation

The purpose of evaluation is to systematically assess the worth or merit of an objective with the goal of providing useful feedback about the object (Trochim, 2006). While there are similarities between methods used in evaluation and research, evaluation focuses on providing useful feedback and quality improvement (Trochim, 2006). Evaluation may be formative or summative. The purpose of formative evaluation is to improve curriculum construction, teaching, and learning (Bloom, Hastings, & Madaus, 1971). Formative evaluation may include needs assessment, implementation evaluation, process evaluation, etc. (Trochim, 2006). On the other hand, summative evaluation is conducted at the completion of a unit, course, or program with “primary goals [of] grading or certifying students, judging the effectiveness of the teacher, and comparing curricula” (Bloom et al., 1971). Examples of summative assessment include outcomes evaluation, impact evaluation, and cost-benefit analysis (Trochim, 2006). In terms of training evaluation, **effective training** is defined as "well-received training that provides relevant knowledge and skills to the participants and the confidence to apply them on the job", whereas **training effectiveness** refers to "training and follow-up leading to improved job performance that positively contributes to key organizational results" (Kirkpatrick & Kirkpatrick, 2016).

Given the complexity of challenges of implementing interventions such as EHRs, the evaluation of educational interventions for IT is challenging (Shachak et al., 2017). To evaluate an educational intervention, five attributes should be evaluated: (1) reliability

(i.e., fidelity to the origin when the intervention is replicated), (2) validity (i.e., its fit with the construct validated), (3) acceptability (i.e., how it is received by those evaluated), (4) feasibility (i.e., how problematic the application of the evaluation may be), and (5) educational impact (i.e., how the evaluation drives learning in the particular knowledge or performance domain that is under evaluation) (Epstein & Hundert, 2002).

For IT training that is provided to support the deployment of EHRs, there is no formal evaluation of such educational interventions (Shachak et al., 2017). Based on the literature and extensive discussions, Shachak et al. (2017) propose that "the reliability of these interventions is unknown (it needs to be measured), the validity is probably fair (it must be useful for functioning in the new environment), that acceptability is good (as EHR training is often mandated by the employers), and the feasibility reasonable (it is happening in large numbers all over the United States)" (p. 473). These gaps underscore the critical need to systematically design and evaluate educational interventions for EHRs and EMRs.

Educational interventions can be evaluated at different levels. Kirkpatrick (1996) described four levels of evaluation:

1. **Reaction:** "a measure of how participants feel about the various aspects of the training program (topic, speaker, schedule, etc.)" (Kirkpatrick, 1996)
2. **Learning:** "a measure of the knowledge acquired, skills improved, or attitudes changed due to training" (Kirkpatrick, 1996)
3. **Behavior:** "a measure of the extent to which participants change their on-the-job behavior because of training" (Kirkpatrick, 1996)

4. **Results:** “a measure of the final results of training (increased sales, higher productivity, bigger profits, reduced costs, improved quality, less employee turnover, etc.)” (Kirkpatrick, 1996)

In applying the Kirkpatrick Model to interprofessional education in health care, Barr et al. (2000) breaks down level 4 into two levels: (4a) change in organisational practice (i.e., wider changes in the organization or delivery of care) and (4b) benefits to patients or clients (i.e., improvements in the health and well-being of patients/clients).

Recently, Kirkpatrick and Kirkpatrick (2016) have also extended the Kirkpatrick Model to develop the New World Kirkpatrick Model. This new model includes the following additions (at each Kirkpatrick level of evaluation):

1. **Reaction:** Engagement (i.e., involvement of the participants in contributing to the learning experience) and relevance (the degree of opportunity that participants have to use or apply what they are learning in training on the job) (Kirkpatrick & Kirkpatrick, 2016).
2. **Learning:** Confidence (i.e., "I think I can do it on the job") and competence ("I intend to do it on the job") (Kirkpatrick & Kirkpatrick, 2016).
3. **Behavior:** "Processes and systems that reinforce, encourage and reward performance of critical behaviors on the job" (Kirkpatrick & Kirkpatrick, 2016).
4. **Results:** “Short-term observations and measurements suggesting that critical behaviors are on track to create a positive impact on desired results” (Kirkpatrick & Kirkpatrick, 2016).

To evaluate EMR training that supports diabetes care based on the CCM, the expanded "Behavior" and "Results" levels of the New World Kirkpatrick Model may be well-suited. Specifically, the "delivery system design" component of the CCM provides a process or system that reinforces, encourages, and rewards PCPs' performance of processes of care for diabetes. Similarly, as per the Structure-Process-Outcome Model by Donabedian (2002), short-term observations (i.e., processes of care and proxy or intermediate measures) can be assessed in the "Results" level to determine if PCPs' critical behaviors are on track to create a positive impact on patients' health outcomes.

## **2.9 Background Literature Review Summary**

As outlined in the background literature, there is a considerable "quality chasm" (i.e., care gaps) in the delivery of diabetes care in Canada and internationally. To address this quality chasm, the use of the CCM has been proposed, as it offers an integrated, multi-faceted approach to redesigning diabetes care quality. An important part of the CCM is the use of IT to improve compliance with clinical practice guidelines and provide feedback on performance measures and registries for planning the care for chronic diseases. At the same time, although EMRs have the great potential to improve the quality of diabetes care through their advanced features, PCP use of these advanced features is limited. Hence, further study of post-implementation EMR training and support is critical; especially newer forms of training such as video tutorials. There is a need to design and evaluate a video tutorial intervention to bridge both the diabetes care gaps and the EMR training gaps in primary care. As part of evaluating the training intervention, process measures should be examined (Renders et al., 2001). The

Kirkpatrick levels of evaluation should also be adopted in designing the training evaluation. The next chapter reviews the literature on EUS, as well as the gaps and national and international research priorities related to improving diabetes care quality through post-implementation EMR training.

## **Chapter 3: Literature Review on End-User Support**

### **3.1 Introduction**

To provide additional context for this research, this chapter outlines the current knowledge on end-user support (EUS) for EMRs and EHRs. A scoping review was undertaken in 2015 to examine the current state of knowledge on EUS for EMRs, as well as to identify research gaps to inform the research problem for this study. Another literature review on EUS for EMRs and EHRs was conducted in 2018 to identify updates to the current state of knowledge. The integrated themes of the scoping review and literature review are presented later in this chapter.

### **3.2 Conceptual Framework**

There is currently a dearth of research on EUS in primary care and only one published framework for characterizing EUS for health information systems (Shachak et al., 2011). According to the conceptual framework developed by Shachak et al. (2011), there are four facets of EUS: (1) the source of support, (2) location of support, (3) support activities, and (4) characteristics of support and support personnel. Shachak et al. (2011) suggest that the support source can be formal (i.e., provided by a vendor) or informal (i.e., provided by a peer/colleague) and personal (i.e., provided by a person) or impersonal (i.e., provided through user documentation or a website). The EUS can be provided on-site or remotely. In terms of support activities, these may include infrastructure support, software support, functional support, data support, and training and education. Lastly, the (perceived) characteristics of support and support personnel

include timeliness, knowledge, homophily, and counselling and communication skills (Shachak et al., 2011).

To increase EMR use by PCPs through EUS, Randhawa (2017) developed a conceptual model that extends the work of Shachak et al. (2011), Venkatesh et al. (2003), and Sharma and Yetton (2007). The model describes the construct (i.e., facilitating conditions or EUS), antecedents (i.e., four facets of EUS), and postcedents and moderators (i.e., pathways and contingent effects) to achieve the key outcome of EMR use behaviour (Randhawa, 2017a). Based on existing theories of technology adoption and use in Health Informatics, the model can be used to explore the relationship between EUS and EMR use (Randhawa, 2017a). However, additional research is needed to test the model (Randhawa, 2017a).

### **3.3 Scoping Review**

As a precursor to this dissertation research, a scoping review was conducted to examine the current state of knowledge on EUS for EMRs and EHRs. A scoping review is "an exploratory project that systematically maps the literature available on a topic, identifying the key concepts, theories, sources of evidence, and gaps in the research" (Canadian Institutes for Health Research (CIHR), 2013, para. 4). As such, it is a preliminary review of the size and scope of literature available for a given topic with the aim of identifying the nature and extent of research evidence. It should be noted that scoping reviews often include all relevant literature regardless of the study design (Arksey & O'Malley, 2005). Scoping reviews are similar to systematic reviews in that they attempt to be systematic, transparent, and replicable (Grant & Booth, 2009);

however, they normally do not attempt to assess the quality of the studies being reviewed or use quality as a criterion for inclusion or exclusion (Arksey & O'Malley, 2005). Scoping reviews help to examine topics that are complex or have not yet been reviewed comprehensively (Arksey & O'Malley, 2005), such as EUS for EMRs.

### **3.3.1 Purpose**

The purposes of the scoping review were to (1) determine the extent, range, and nature of research activity on EUS for EMRs and EHRs, (2) summarize the research findings on EUS for EMRs and EHRs, and (3) identify research gaps in the existing literature on EUS for EMRs and EHRs. The scoping review used the iterative, five-stage methodology identified by Arksey & O'Malley (2005) to ensure that the literature on EUS is covered in a comprehensive way:

- Stage 1: Identifying the research question
- Stage 2: Identifying relevant studies
- Stage 3: Study selection
- Stage 4: Charting the data
- Stage 5: Collating, summarizing and reporting the results

### **3.3.2 Methodology**

The literature search for the scoping review was conducted from June-July 2015 using the following eight **databases**:

1. PubMed
2. Compendex (Engineering Village)

3. Web of Science
4. Google Scholar
5. Business Source Complete
6. CINAHL
7. IEEE Explore
8. The Association for Information Systems's (AIS) digital library

The following free-text **search terms** were used for each database:

["End-user support" OR "End-User Computing Support" OR "EUC Support" OR "Training" OR "Technical support" OR "Champion" OR "Super-User" OR "User Manual" OR "Tutorial" OR "Helpdesk" OR "Peer mentor" OR "Information Center" OR "Information Centre" OR "Information Technology Support" OR "IT Support" OR "IT Support Services"] AND

["Health Information Systems" OR "Medical Information Systems" OR "Electronic Health Records" OR "EHR" OR "Electronic Medical Records" OR "EMR" OR "Electronic Paper Records" or "EPR"].

Additionally, hand searching of the University of Victoria's (UVic) Research and Learning Repository was conducted to find relevant theses. A prior personal collection of articles from the researcher's Master's thesis work was also reviewed and reference mining of select articles was also conducted.

### **3.3.3 Inclusion Criteria**

The articles were limited to English language articles published before July 2015. In addition to peer-reviewed articles, theses, commentaries, and editorials were included. Included articles had to discuss some aspect of EUS during pre- or post-implementation of the EMR/EHR.

### **3.3.4 Exclusion Criteria**

Articles focusing solely on the following topics were removed: barriers or facilitators to EMR/EHR adoption, end-user acceptance, end-user attitudes, end-user satisfaction, computer literacy, computer use and job satisfaction, and EMR/EHR use.

### **3.3.5 Data Extraction**

Data extraction and charting of included records included:

- Publication year;
- Study location (i.e., country);
- Type of record/article (e.g., primary study, commentary, literature review, etc.);
- Health care setting (e.g., primary care, acute care, etc.);
- Study purpose;
- End-user type (e.g., PCP, nurse, etc.);
- Details of EUS provided during pre-implementation and post-implementation;
- Research methodology;
- Research design;
- Data collection methods;

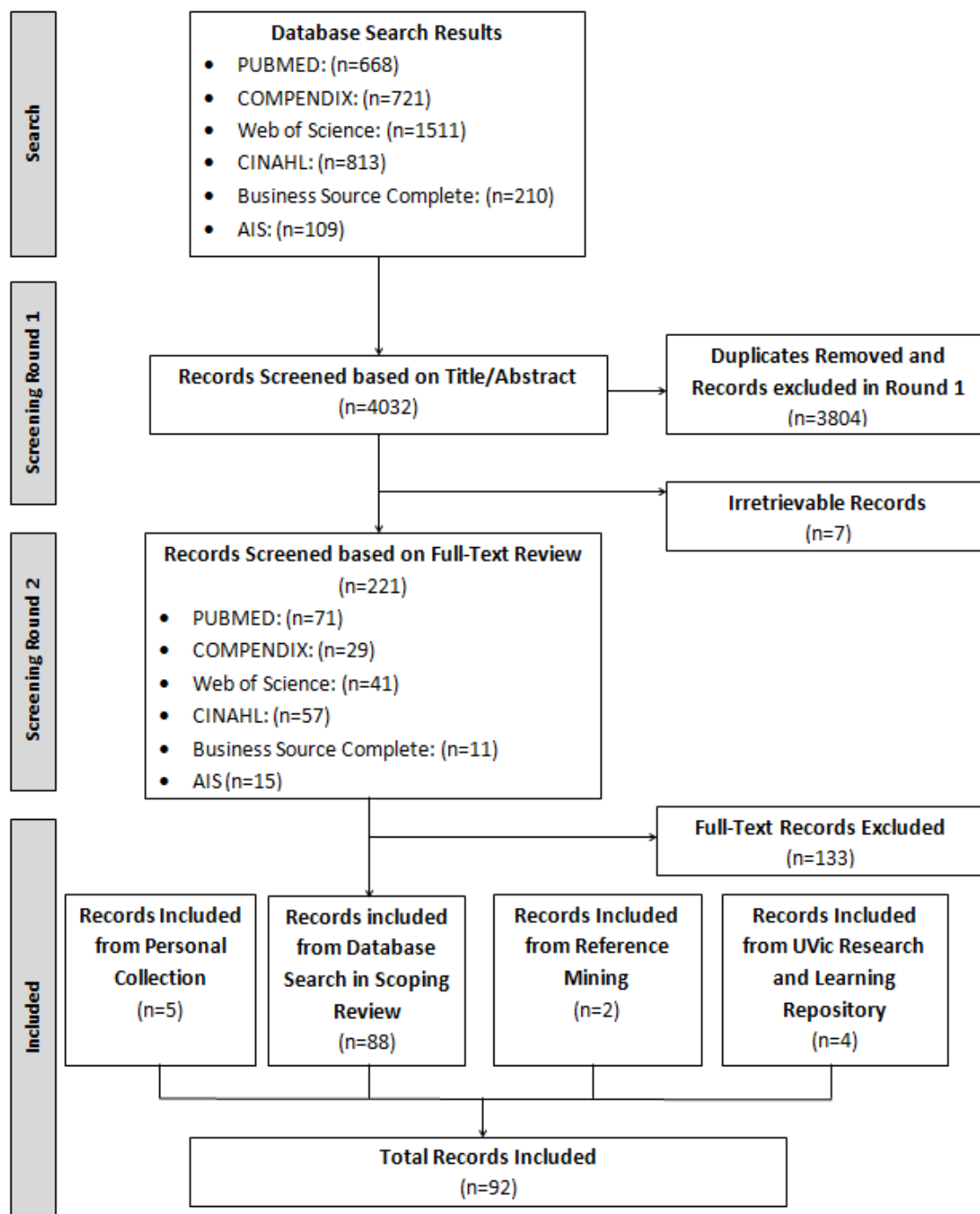
- Sample size;
- Theories used/discussed; and
- Research gaps/directions for future research.

### **3.3.6 Data Analysis/Synthesis**

Themes (i.e., patterns in the literature/data) and sub-themes from the results of the included articles were identified and iteratively refined for EUS. To categorize the themes, major theme areas were generated. Themes in the research gaps and directions for future research were also identified. A theme/concept map was developed to illustrate the "map" of the literature available on EUS for EMRs.

### **3.3.7 Results**

A total of 4,032 articles were retrieved from the database searches conducted in July 2015. Following removal of duplicates and a review of titles and abstracts, 221 articles were identified for full-text review and secondary screening in July 2015. Based on the full-text review, 88 papers were included in the scoping review. In addition, two articles were included from reference mining, five were included from a personal collection, and four theses were included from a search of the UVic Research and Learning Repository. In total, 92 records were included in the scoping review. A flowchart of the search can be seen in Figure 4 below.



**Figure 4 Scoping Review Flowchart**

A large number of articles (n=133) were excluded following full-text review due to their focus on EMR adoption, end-user acceptance, end-user attitudes, end-user

satisfaction, computer literacy, computer use and job satisfaction, and/or EMR use.

Seven articles that appeared to be relevant during the first round of screening could not be retrieved through the UVic Library or Inter-Library Loan and were therefore excluded.

The next sections provide a summary of the scoping review results.

### Results by Publication Year

Figure 5 below illustrates the publication of the included EUS literature by year. In general, the number of annual publications has increased since 2003 and had peaked in 2013. In 2010, the number of publications increased over two-fold from four to eleven articles. This may be due to the introduction of government-sponsored incentive programs designed to accelerate the adoption and MU of EMRs, such as the Health Information Technology Extension Program in the United States (in 2009) and PITO in Canada (in 2006).

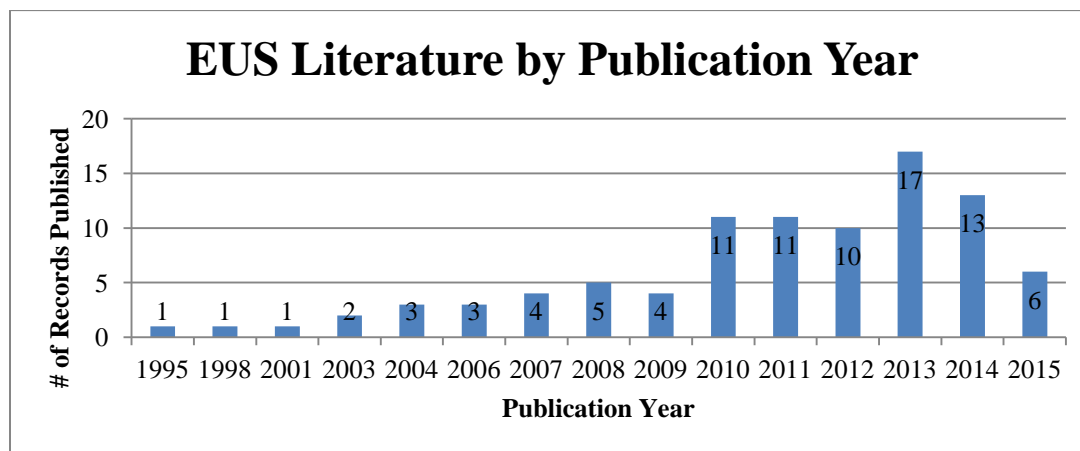


Figure 5 EUS Literature by Publication Year

### Results by Study Location

Figure 6 depicts the distribution of the included records by study location. The vast majority of records have been published in the United States, followed by Canada.

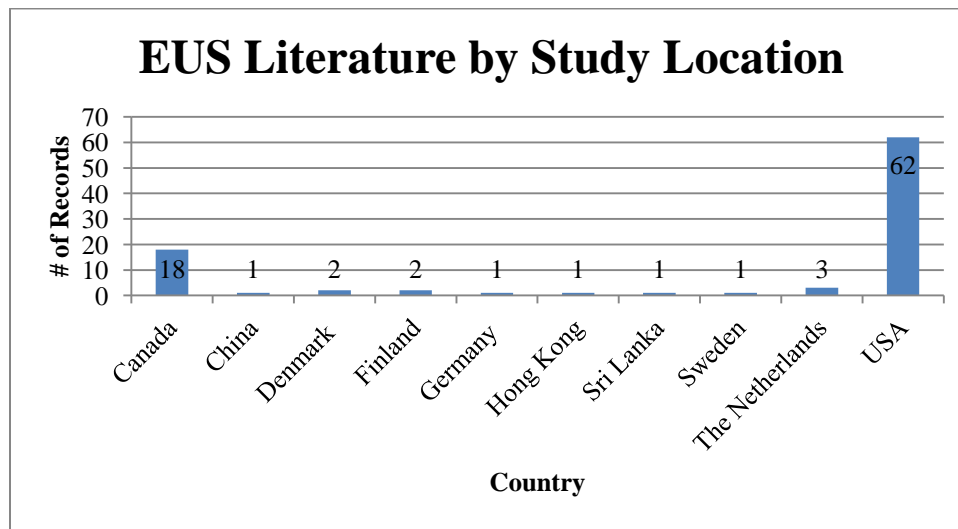


Figure 6 EUS Literature by Study Location

### Results by Type of Record

Figure 7 illustrates the distribution of the included records by type of record. The majority of records are primary studies or commentaries.

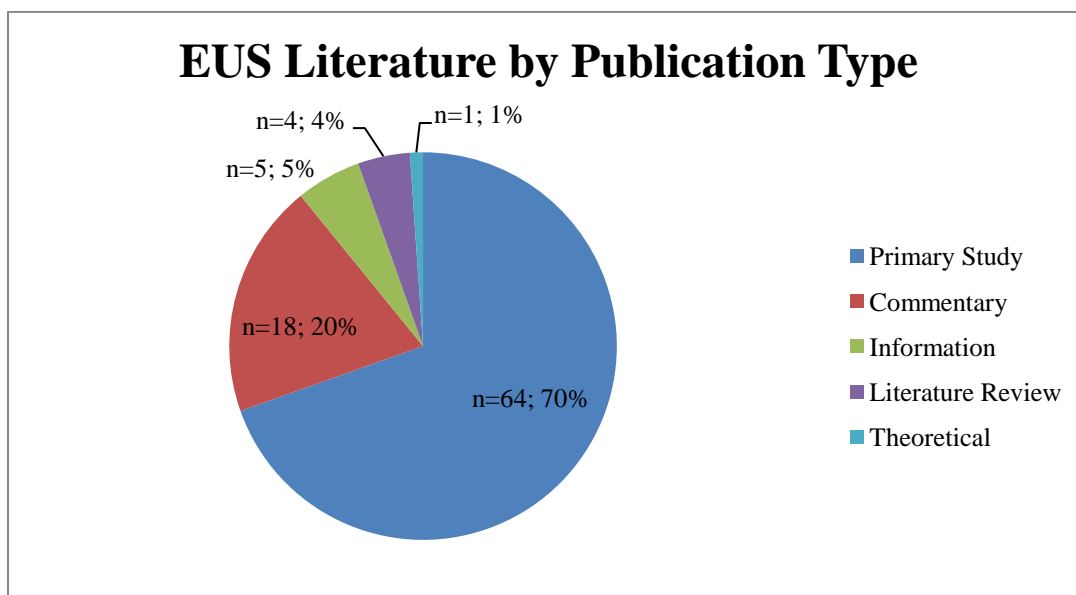


Figure 7 EUS Literature by Publication Type

### Results by Health Care Setting

Figure 8 depicts the distribution of the included publications by health care setting. The majority of articles were set in the primary care setting, followed by the acute care setting.

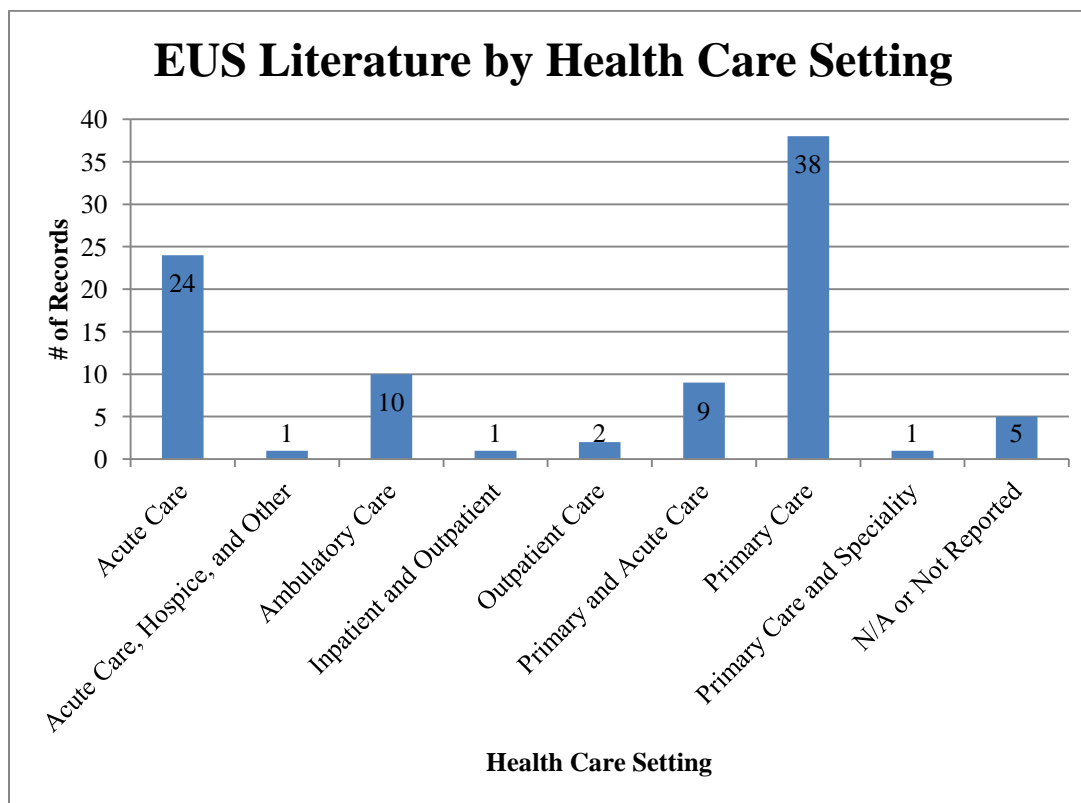
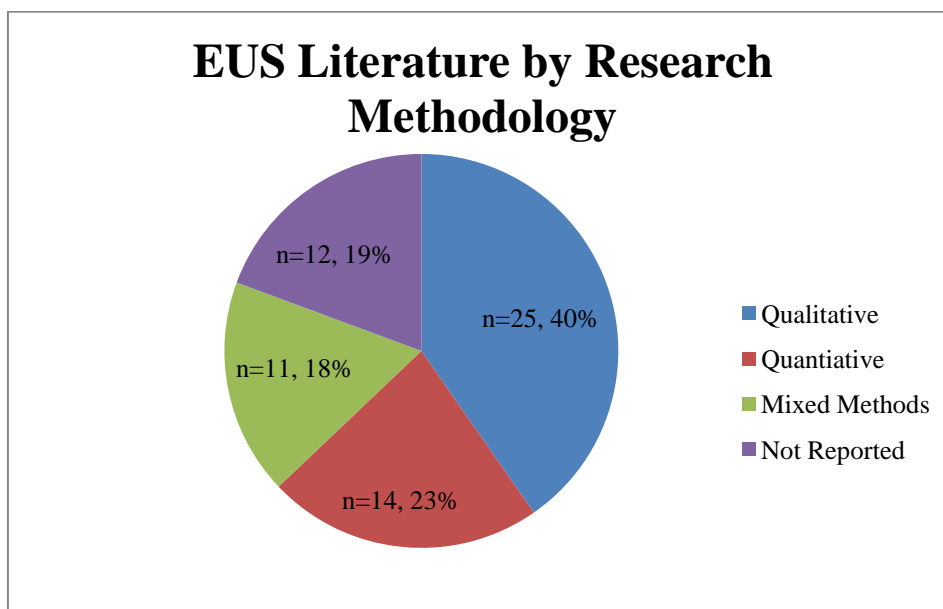


Figure 8 EUS Literature by Health Care Setting

### Results by Research Methodology

Figure 9 illustrates the distribution of the included records by research methodology. The majority of studies were conducted using qualitative methodology.



**Figure 9 EUS Literature by Research Methodology**

### **3.4 Literature Review Update**

A literature review was conducted in Google Scholar for EUS literature published between August 2015 and August 2018 using search terms from the aforementioned scoping review. Twelve additional studies were included in the literature review on EUS.

### **3.5 Themes from EUS Literature**

In total, the scoping review and literature review revealed four major theme areas (i.e., categories), 18 themes, and 36 sub-themes related to EUS in the context of EMRs and EHRs. The theme areas include (1) "types of EUS," (2) "inadequate EUS," (3) "the role of EUS in EMR adoption and use," and (4) "delivering EUS." Details of these themes and sub-themes can be seen in Table 2 below.

Table 2 Themes from EUS Literature

Theme Area	Theme	Sub-Theme(s)
Types of EUS	Training	<ol style="list-style-type: none"> <li>1. <b>Learning Needs</b> (Agno &amp; Guo, 2013; P. He et al., 2014; Peck, 2013) <ol style="list-style-type: none"> <li>a. <b>Individual and Practice Needs</b> (Bygholm, 2001; Denomme et al., 2011; Goveia et al., 2013; Haugen, 2012; Hess, 2011; Jimenez, 2010; Joukes, Cornet, &amp; Abu-hanna, 2015; Kariyawasam, Turner, &amp; Dayaratne, 2013; Kim et al., 2014; Laramée, Bosek, Kasprisin, &amp; Powers-Phaneuf, 2011; Lemmetty et al., 2009; Peck, 2013; Puffer et al., 2007; Smith, 2013)</li> <li>b. <b>Learning and Training Methods</b> (Bergeron, 2006; Edwards et al., 2012; Goveia et al., 2013; Janols et al., 2014; Jimenez, 2010; Kim et al., 2014; Lorenzi et al., 2009; McAlearney et al., 2012; Smith, 2013).</li> </ol> </li> <li>2. <b>Pre-Implementation Training</b> (Agno &amp; Guo, 2013; Cascardo, 2007; Crosson et al., 2011; Kirshner, Salomon, &amp; Chin, 2004; Lemmetty et al., 2009) <ol style="list-style-type: none"> <li>a. <b>Benefits</b> (Denomme et al., 2011; Hess, 2011; Smith, 2013)</li> <li>b. <b>Timing of Training</b> (Cascardo, 2007; Dastagir et al., 2012; Fenton et al., 2006; Krall, 1995; McAlearney et al., 2012; Pantaleoni et al., 2015)</li> <li>c. <b>Format</b> (Alkureishi, Lee, Webb, &amp; Arora, 2018; Clarke, Belden, &amp; Kim, 2016; He et al., 2016; Janols et al., 2014; Kim, Rodriguez, Estlin, &amp; Morris, 2017; Krishnan, Wald, Rougas, Zink, &amp; Taylor, 2017; Mohan et al., 2016; Mohan, Scholl, &amp; Gold, 2015; Reis et al., 2013; Shachaket al. 2013; Shachak et al., 2015; Stromberg, 2011; Stuttgart, 2017; Thiyagarajan et al., 2017)</li> <li>d. <b>Location</b> (McAlearney et al., 2012)</li> </ol> </li> <li>3. <b>Post-Implementation Training</b> (Bredfeldt et al., 2013; Hill, Stewart, &amp; Ash, 2010; Lau, Partridge, Randhawa, &amp; Bowen, 2013; Lemmetty et al., 2009; Peck, 2013; Puffer et al., 2007; Sorensen, 2013) <ol style="list-style-type: none"> <li>a. <b>Benefits</b> (Ash, Stavri, Dykstra, &amp; Fournier, 2003; Dastagir et al., 2012; Kulhanek, 2011; Or, Wong, Tong, &amp; Sek, 2013)</li> <li>b. <b>Timing of Training</b> (Lau et al., 2013; Mettler, 2014; Sorensen, 2013)</li> <li>c. <b>Format</b> (Dennehy et al., 2011; Fernald et al., 2013; Figlietti, 2017; Granlien, Hertzum, &amp; Gudmundsen, 2008; Kamath et al., 2006; Kirshner et al., 2004; Lowes, 2004; Peck, 2013; Puffer et al., 2007; Shachak et al., 2013)</li> </ol> </li> <li>4. <b>Training Design</b> (Hess, 2011; Lemmetty et al., 2009; McIntire &amp; Clark, 2009; Pantaleoni et al., 2015)</li> </ol>

Theme Area	Theme	Sub-Theme(s)
		<p><b>a. Learning Context</b></p> <ul style="list-style-type: none"> <li>i. <b>Learners</b> (Crowley et al., 2018; Denomme et al., 2011; Krall, 1995; Lorenzi et al., 2009; Pantaleoni et al., 2015; Youssef, 2013)</li> <li>ii. <b>Trainers</b> (Birk, 2010; Bredfeldt et al., 2013; Green et al., 2015; P. He et al., 2014; Kariyawasam et al., 2013; Kim et al., 2014; Koo &amp; Ph, 2004; Lorenzi et al., 2009; Lowes, 2004; Pantaleoni et al., 2015)</li> <li>iii. <b>Classroom Size</b> (Birk, 2010; Blair &amp; Schutte, 2003; Jalota et al., 2014; Kirshner et al., 2004)</li> <li>iv. <b>Location</b> (Birk, 2010; Blair &amp; Schutte, 2003; Bredfeldt et al., 2013; DeVore &amp; Figlioli, 2010; Jalota et al., 2014; Kamath et al., 2006; Kirshner et al., 2004; Lemmetty et al., 2009; Mcintire &amp; Clark, 2009; Pantaleoni et al., 2015; Skillman, Andrilla, Patterson, Fenton, &amp; Ostergard, 2015; Youssef, 2013)</li> <li>v. <b>Learning Outcomes</b> (Adewale, Anthony, &amp; Borkan, 2014; Peck, 2013)</li> </ul> <p><b>b. Pre-Assessment/Computer Literacy</b> (Dennehy et al., 2011; Gamm et al., 1998; Goveia et al., 2013; Jalota et al., 2014; Lowes, 2004; Mcintire &amp; Clark, 2009)</p> <p><b>c. Teaching Strategies</b> (Kamath et al., 2006; Koo &amp; Ph, 2004; Nechyporenko &amp; McKibbon, 2015)</p> <p><b>d. Timing/Length of Training</b> (Goveia et al., 2013; Haugen, 2012; Jalota et al., 2014; McAlearney et al., 2012; Randhawa, Lau, &amp; Price, 2013; Stromberg, 2011)</p> <p><b>e. Assessment</b> (Ames, Ciotti, &amp; Mathis, 2011; Goveia et al., 2013; Pantaleoni et al., 2015)</p> <p><b>f. Training Evaluation</b> (Kirshner et al., 2004; Pantaleoni et al., 2015; Rhodes, Short, &amp; Shaben, 2017; Stromberg, 2011)</p> <p><b>g. Adult Education Principles</b> (Bygholm, 2001; Edwards et al., 2012; Haugen, 2012; Jimenez, 2010; McCain, 2008; Pantaleoni et al., 2015; Puffer et al., 2007; Smith, 2015; Sorensen, 2013; Stromberg, 2011; Youssef, 2013)</p> <p><b>h. Learning Management System</b> (Pantaleoni et al., 2015; Wheeler, 2007)</p>
	<b>Super-Users</b>	<p>1. <b>Identification of Super-Users</b> (Hess, 2011; Lowes, 2004; McAlearney et al., 2012; McBride, 2012; Mcintire &amp; Clark, 2009; Peck, 2013; Shachak, Barnsley, Montgomery, et al.,</p>

Theme Area	Theme	Sub-Theme(s)
		<p>2012).</p> <ol style="list-style-type: none"> <li>2. <b>Role of Super-Users</b> (Gray, 2011; Halbesleben, Wakefield, Ward, Brokel, &amp; Crandall, 2009; Lowes, 2004; McAlearney et al., 2012; Peck, 2013; Shachak et al., 2013; Simmons, 2013) <ol style="list-style-type: none"> <li>a. <b>Pre-Implementation</b> (Agno &amp; Guo, 2013; Birk, 2010; Yuan, Bradley, &amp; Nembhard, 2015)</li> <li>b. <b>Go-Live</b> (Crosson et al., 2011)</li> <li>c. <b>Post-Implementation</b> (Simmons, 2013)</li> </ol> </li> <li>3. <b>Training/Development of Super-Users</b> (Bygholm, 2001; Halbesleben et al., 2009; McIntire &amp; Clark, 2009; Peck, 2013; Simmons, 2013; Yuan et al., 2015)</li> </ol>
	<b>Champions</b>	<ol style="list-style-type: none"> <li>1. <b>Identification of Champions</b> (Crosson et al., 2011; Dastagir et al., 2012; DeVore &amp; Figlioli, 2010; Fenton et al., 2006; McAlearney, Hefner, Sieck, Rizer, &amp; Huerta, 2014; Pantaleoni et al., 2015)</li> <li>2. <b>Role of Champions</b> (Crosson et al., 2011; Denomme et al., 2011; Fenton et al., 2006; Gagnon et al., 2010; Lorenzi et al., 2009; Luchetski, 2010; Pantaleoni et al., 2015; Tilahun &amp; Fritz, 2015)</li> <li>3. <b>Characteristics of Champions</b> (Ash et al., 2003; Fenton et al., 2006; Janols et al., 2014; Lorenzi et al., 2009; Lowes, 2008)</li> <li>4. <b>Training/Development of Champions</b> (Peck, 2013)</li> </ol>
	<b>User Documentation</b>	(Bredfeldt et al., 2013; Cascardo, 2007; Clarke et al., 2016; Darking et al., 2014; Janols et al., 2014; Kirshner et al., 2004; Laramée et al., 2011; Shachak et al., 2013; Shachak, Dow, et al., 2013; Shachak, Montgomery, et al., 2013)
	<b>Technical Support</b>	(Goldberg, Kuzel, Feng, DeShazo, & Love, 2012; Ludwick, Manca, & Doucette, 2010; Petersen, 2010)
	<b>Peer Mentoring</b>	(Denomme et al., 2011; Mettler, 2014; Rimmer et al., 2014; Watt, 2014)
	<b>Coaching</b>	(Fernald et al., 2013; Goveia et al., 2013; Watt, 2014)
	<b>Collaborative Learning/ Sharing</b>	<ol style="list-style-type: none"> <li>1. <b>Learning Collaborative</b> (Denomme et al., 2011; Fernald et al., 2013; Torda, Han, &amp; Scholle, 2010)</li> <li>2. <b>Community of Practice</b> (Rimmer et al., 2014)</li> <li>3. <b>Online User Community</b> (Nambisan, 2014; Peck, 2013)</li> </ol>
	<b>Help Desk</b>	(Birk, 2010; Crosson et al., 2011; Dastagir et al., 2012; Jalota et al., 2014)
	<b>Quality Improvement</b>	(Adewale et al., 2014; Fernald et al., 2013; Ryan et al., 2014)
	<b>Feedback</b>	(Denomme et al., 2011; Goveia et al., 2013)
<b>Inadequate EUS</b>	<b>Inadequate Training</b>	<ol style="list-style-type: none"> <li>1. <b>Training Barriers</b> (Adewale et al., 2014; Ames et al., 2011; Fritz, Tilahun, &amp; Dugas, 2015; Graham-Jones, Jain, Friedman, Marcotte, &amp; Blumenthal, 2012; Joukes et al., 2015; Kamath et al., 2006; Kim et al., 2014; Koo &amp; Ph, 2004; Kruse, Hays, Orav, Palan, &amp; Sequist, 2017; Lau et al., 2013; Randhawa, 2013; Shachak et al. 2013)</li> </ol>

Theme Area	Theme	Sub-Theme(s)
		<ol style="list-style-type: none"> <li>2. <b>Satisfaction with Training</b> (Edsall &amp; Adler, 2012; Ludwick et al., 2010)</li> <li>3. <b>Inadequate Post-Implementation Training</b> (DeVore &amp; Figlioli, 2010; Green et al., 2015; Kim et al., 2014; Lau et al., 2013; Lemmetty et al., 2009)</li> </ol>
	<b>Inadequate Technical Support</b>	(Adewale et al., 2014; Agno & Guo, 2013; Crosson et al., 2011; Fernald et al., 2013; Fernando, 2010; Kim et al., 2014; Ludwick et al., 2010; Smith, 2013)
<b>The Role of EUS in EMR Adoption and Use</b>	<b>Meaningful EMR Use</b>	(Goldberg et al., 2012; Haugen, 2012; Joukes et al., 2015; Mettler, 2014; Randhawa et al., 2013; Watt, 2014)
	<b>Effects of EUS on EMR Use</b>	<ol style="list-style-type: none"> <li>1. <b>Effects on EMR Adoption</b> (Bramble et al., 2010; Haugen, 2012; Samuel, 2014)</li> <li>2. <b>Effects on EMR Meaningful Use</b> (Bullard, 2014; Denomme et al., 2011; Goveia et al., 2013; L. Green et al., 2015; P. He et al., 2014; Rimmer et al., 2014; Samuel, 2014; Simmons, 2013; Watt, 2014)</li> <li>3. <b>Effects on Productivity and Physician Satisfaction</b> (Dastagir et al., 2012; Dennehy et al., 2011; Jalota et al., 2014; Kirshner et al., 2004)</li> <li>4. <b>Effects on Patient Outcomes and Quality of Care</b> (Ryan, Bishop, Shih, &amp; Casalino, 2013; Shachak et al., 2013)</li> <li>5. <b>Unintended Effects</b> (Stromberg, 2011)</li> </ol>
<b>Delivering EUS</b>	<b>EMR Support Incentives</b>	<ol style="list-style-type: none"> <li>1. <b>Physician Information Technology Office (PITO)</b> (Rimmer et al., 2014; Watt, 2014)</li> <li>2. <b>Regional Extension Centers (REC)</b> (Green et al., 2015; Ryan et al., 2013; Torda et al., 2010)</li> <li>3. <b>Primary Care Information Project (PCIP)</b> (Ryan et al., 2014, 2013)</li> <li>4. <b>Continuing Medical Education (CME) Credits</b> (Bredfeldt et al., 2013; Jimenez, 2010; Kirshner et al., 2004; Pantaleoni et al., 2015; Watt, 2014)</li> <li>5. <b>Protected Time for EMR Training</b> (Randhawa et al., 2013)</li> </ol>
	<b>Characteristics of End-User Supporters</b>	<ol style="list-style-type: none"> <li>1. <b>Educational Background</b> (Ash et al., 2003; Fritz et al., 2015; Lynott, Kooienga, &amp; Stewart, 2012; Maples, 2014)</li> <li>2. <b>Skills</b> (Bygholm, 2001; Fenton et al., 2006; Fritz et al., 2015; Gagnon et al., 2010; Jalota et al., 2014; Lemmetty et al., 2009; Lorenzi et al., 2009; Shachak et al., 2013)</li> <li>3. <b>Personal Attributes</b> (Ash et al., 2003; Birk, 2010; Fritz et al., 2015; Gagnon et al., 2010; Laramee et al., 2011; McIntire &amp; Clark, 2009; Shachak et al., 2013; Simmons, 2013; Stevens, Pantaleoni, &amp; Longhurst, n.d.)</li> <li>4. <b>Teaching Ability</b> (Ash et al., 2003; Fritz et al., 2015; Kirshner et al., 2004; Pantaleoni et al., 2015)</li> <li>5. <b>Availability</b> (Ames et al., 2011)</li> </ol>
	<b>Role and Timing of Support</b>	(Mettler, 2014)

## **3.6 Research Gaps and Directions for Future Research**

Four areas of research gaps/future directions for EUS research emerged from the scoping review (in increasing order of frequency): user-documentation, super-users, general end-user support, and training. These gap areas are described below.

### **3.6.1 User Documentation**

There is a need to evaluate the differences between vendor- and user-generated tutorials and manuals using a large sample size for various types of EMR software (Shachak, Dow, et al., 2013). The reasons for and process of developing tutorials and manuals by users and their design considerations should also be examined (Shachak, Dow, et al., 2013).

### **3.6.2 Super-User Support**

Past research on super-users (i.e., a specific type of EUS) is limited (Yuan et al., 2015). There is little research on how super-users enhance EHR implementation while improving employee experiences with the system. There is a need to research: (a) mechanisms by which super-users influence implementation success (Yuan et al., 2015), (2) the contribution of super-user roles in the overall outcomes of EMR use and ongoing training of new staff (Mcintire & Clark, 2009), and (3) how super-users' selection and behaviors affect implementation outcomes (Yuan et al., 2015).

### **3.6.3 General End-User Support**

There is little research on how to generally support end-users (Bygholm, 2001) and ways to optimize end-user training and support (Dastagir et al., 2012), as well as the

definition of optimal support and how it can be achieved (Mettler, 2014). Watt (2014) recommends studying EMR usage barriers such as readiness to adopt higher functionality (Watt, 2014). As of 2014, there was no research on the effect of direct support for physicians to improve EMR use in British Columbia or Canada (Watt, 2014).

There is a need to understand the role of informal support in relation to information quality, health management and preventive medicine, and the role of formal support in relation to system quality, individual impact, and patient safety (Dow, 2012). Shachak et al. (2011) suggest that these outcomes be further investigated to contribute to the theoretical understanding of end-user support. Further, this would allow for the links between end-user support and EMR success to be investigated (Dow, 2012). Dow (2012) and Shachak et al. (2012) suggest that their theoretical models of end-user support can be used to provide the foundation for a larger-scale, quantitative study of the relationships between end-user support and EMR use by developing a valid survey for distribution at the provincial or national level.

Mettler (2014) recommended studying the effects of more pre-implementation EUS on the demand for support during post-implementation (Mettler, 2014). She also suggested research to determine if support during both pre- and post-implementation is a critical success factor for EMR use (Mettler, 2014), as well as the relationship between post-implementation support and maturity (Mettler, 2014). There is also a need to investigate EMR users' needs, expectations, and perceptions of support compared to the vendor's perspective (Shachak et al., 2012).

### 3.6.4 Training

There is a major gap in knowledge on how to effectively equip physicians, nurses, and other healthcare professionals to use EHRs in a meaningful way (Goveia et al., 2013); therefore, there is a significant need to study how to optimize end-user training and support (Bredfeldt et al., 2013; Edwards et al., 2012). There are few studies on advanced EHR proficiency training of clinicians (Bredfeldt et al., 2013). Most of the focus of studies has been on training at the time of system implementation and not post-implementation (Bredfeldt et al., 2013). As such, the effects of post-implementation EHR training on experienced end-users should be studied (Dastagir et al., 2012), including physicians and Medical Assistants (Adewale et al., 2014). In particular, it is critical to study the needs of physicians with limited computer exposure, older age, and those who fail to improve with clinical practice on an EHR (Jalota et al., 2014).

Existing studies on educational EHR interventions report results in qualitative terms (Goveia et al., 2013). There is little research on the effects of educational interventions on MU for EHRs, and there is little use of standardized evaluation tools for educational interventions (Goveia et al., 2013). The literature has not examined the highest level of Kirkpatrick (i.e., results) (Goveia et al., 2013). Therefore, measures beyond satisfaction with training and assessments of user performance in care settings, as well as the impact of user performance on long-term organizational and health outcomes should be investigated (Edwards et al., 2012). Specifically, there is a lack of comparative research designs to determine the efficacy of educational interventions (Goveia et al., 2013) or to determine the best methodology of training (Edwards et al., 2012; Jalota et al., 2014).

It has been suggested that multifaceted interventions (e.g., combination of classroom teaching, computer-based training, and personal guidance or feedback) should be studied, especially to determine the educational or orientation strategies that are most effective in (a) preparing interdisciplinary team members to transition to using an EHR (Laramee et al., 2011) and (b) helping providers to maintain a high level of EHR competency and efficiency across many tasks (Bredfeldt et al., 2013). At the same time, there is a need to research the costs and benefits of various methodologies for advanced EHR training (Jalota et al., 2014). These interventions should: (a) take place in the research setting (Goveia et al., 2013), (b) measure short and long-term effects on EHR use (Goveia et al., 2013), and (c) include training instructors with clinical backgrounds (Fritz et al., 2015). It has been recommended that future research be of high methodological quality with standardized outcome measures to support general recommendations on how to optimize MU (Goveia et al., 2013).

The identified EMR training gaps in the literature are also reinforced by the 2014 National Physician Survey, which reports that 17% of Canadian PCPs using EMRs have reported "lack of training" as a barrier in accessing electronic records, with older PCPs reporting this as a greater barrier (NPS, 2014d). In another provincial EMR Physician Satisfaction Survey, 72% of physicians reported that they could benefit from more training to advance use of their EMR (Saskatchewan EMR Program, 2012). Canada Health Infoway (2013) also suggests that post-implementation training and coaching from clinician peer leaders will result in the use of additional, more advanced EMR features. Similarly, in the context of chronic illness care, recent research also

recommends the need for provider training to improve the use of eHealth tools such as EMRs (Gee et al., 2015).

### **3.7 EUS Literature Review Summary**

The literature review reveals the diverse and multi-faceted nature of EUS for EMRs and EHRs. The current body of knowledge on EUS highlights four key areas of research gaps and directions for future research: user documentation, super-users, general EUS, and training. The biggest EUS research gap is EMR/EHR training, which requires additional research using mixed methods design with a quantitative emphasis. Specifically, there is a need for further research on the effects of post-adoption EMR training interventions for improving patient care through advanced EMR use (Bredfeldt et al., 2013; Dastagir et al., 2012; Edwards et al., 2012; Goveia et al., 2013). Further, the literature on EUS interventions such as training has not been examined its impact on user performance and organizational outcomes (Edwards et al., 2012; Goveia et al., 2013). At the same time, there are few studies on the use of training instructors with clinical backgrounds (Fritz et al., 2015).

## Chapter 4: Purpose of the Study

### 4.1 Research Rationale

The aforementioned research gaps from the literature provide a unique opportunity to evaluate video tutorials as a post-implementation EMR training intervention for diabetes care. Specifically, there is a need to integrate six co-aligned models and concepts to address the research gaps: (1) the CCM, (2) value-adding EMR use, (3) evidence-based video tutorial design, (4) clinician-led EMR training, (5) the Structure-Process-Outcome Model, and (6) the New World Kirkpatrick Model. Together, these components provide the ingredients necessary to design and evaluate a new educational intervention for EMRs to inform the planning of future post-implementation EMR training efforts.

Diabetes care has been selected as the NCD of interest due to its generalizability to other chronic diseases (i.e., ability to apply the process measure concepts of diabetes care to other NCDs). Specifically, this research study involves testing a video tutorial intervention that is based on (1) the CCM, (2) Level 4 of BC's Clinical Value Model, and (3) the best practices for video tutorial design. The video tutorial is led by a clinician and the format has been selected to cater to physicians' need for self-paced learning.

As a summative evaluation, this research will help to investigate *effective training* and *training effectiveness* of the intervention through a mixed methods approach. To measure changes in value-adding use of the EMR, the study will employ the New World

Kirkpatrick Model and Structure-Process-Outcome Model to evaluate PCPs' EMR use behavior for diabetes care before and after the intervention. Both models emphasize the importance of measuring the “processes” or “short-term observations” that help to produce results (i.e., changes in health outcomes). This will help to answer the first research question of the study. Given the behavioral change aspect of this research, the barriers and facilitators to applying the intervention will be examined to better understand success factors for implementing the training into PCPs' practice (i.e., research question 2). Similarly, it is important to understand if there are any relationships between PCP characteristics (research question 3), and if any PCP characteristics affect EMR use for diabetes care (research question 4).

## **4.2 Research Objective**

To evaluate the potential of a CCM-based post-implementation EMR training intervention (i.e., video tutorials) to improve process measures for type 1 and type 2 diabetes care.

## **4.3 Research Questions**

This study addresses the following research questions:

1. To what extent does a CCM-based post-implementation EMR training intervention (i.e., video tutorials) demonstrate the potential to improve process measures for type 1 and type 2 diabetes care, including (a) use of a diabetes registry, (b) use of diabetes recalls/reminders, (c) ordering/viewing a patient's

Hemoglobin A1C every 3-6 months, and (d) recording a patient's blood pressure every 3-6 months?

2. What are the barriers and facilitators to applying the CCM-based post-implementation EMR video tutorials-based training into PCPs' practice?
3. What are the relationships between the personal characteristics of PCPs who are interested in improving their EMR use for diabetes care?
4. To what extent do individual PCP characteristics relate to EMR use for diabetes care?

## Chapter 5: Methodology

### 5.1 Approach

To address the research objective and research questions above, this study employed a mixed methods approach. The mixed methods approach includes the collection and analysis of both qualitative and quantitative data in a single study. This approach assumes the need to use qualitative and quantitative methods to do the following: (a) enhance the accuracy and meaningfulness of the research conclusions, (b) have a complete picture of a situation, and (c) reconfirm research findings (Gray, 2014).

The quantitative research aspect in this research allows for the analysis of process measures before and after an intervention and for generalizations from a sample to a population to gain a richer, contextual understanding of the phenomenon being researched (Hanson, Clark, Petska, Cresswell, 2005). At the same time, the qualitative aspect allows for the analysis of physicians' expressions and actions embedded in a local context. Miles and Huberman (1994) suggest that the combination of careful measurement, generalizable samples, experimental control and statistical tools with in-depth understanding of complex real-world contexts creates a "very powerful mix" in terms of research methodology (Hanson, Clark, Petska, Cresswell, 2005).

## 5.2 Research Design

For the research problem at hand, an Embedded Design was used to best tackle the research questions. In the Embedded Design, one data set provides a supportive, secondary role in a study based primarily on the other data type (Cresswell & Clark, 2007, p. 67). This design is useful for the development of a treatment, examination of an intervention, and the follow up of experiment results (Cresswell & Clark, 2007).

This design includes qualitative data embedded within an experimental design (e.g., true experiment or quasi-experiment) (Cresswell & Clark, 2007). Further, a two-phase design was used to sequentially collect qualitative data after the intervention (Figure 10). The study gave priority to quantitative data (denoted QUAN(qual)) for mixed methods notation). Qualitative and quantitative data were used to follow up on the results of the intervention.

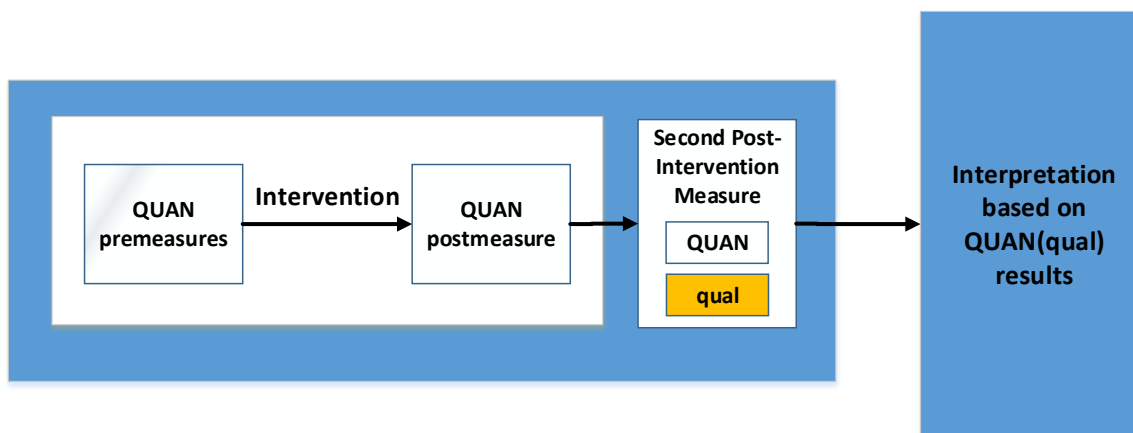


Figure 10 Embedded Experimental Design (adapted from Cresswell & Clark, 2007)

### 5.2.1 Research Design for Intervention/Experiment

The experimental portion of the study used a quasi-experimental design, with a one-group pretest post-test using a double pre-test and an additional post-intervention measurement. In this design (Figure 11), treatment was delivered to all participants and outcomes were examined before and after the treatment was implemented (Sidani, 2015). In Figure 11, the X represents the intervention and the O's represent the points in time in which data were collected. The inclusion of two pre-tests (O1 and O2) "function as a "dry run" to clarify the biases that may exist in estimating the effects of the treatment from O2 to O3" (Shadish, Cook, & Campbell, 2002).

<b>O1</b>	<b>O2</b>	<b>X</b>	<b>O3</b>	<b>O4</b>
<i>(Observational Measurement 1)</i>	<i>(Observational Measurement 2)</i>	<i>(Intervention)</i>	<i>(Observational Measurement 3)</i>	<i>(Observational Measurement 4)</i>

**Figure 11 Extended One-Group Pre-Test Post-Test Using a Double Pre-Test Design**

Data were collected one month before (O1), immediately before (O2), three months after (O3), and six months after the intervention (O4). Data collected at O1 served as the baseline or pre-intervention measurement. O3 is the post-intervention measurement. The additional post-intervention measurement at O4 was included to help refute confounding and the phenomenon of regression to the mean if there is any association observed between the intervention and post-test outcome (Harris et al., 2006). In addition, O4 was included to allow enough time for time-sensitive process measures and clinical indicators for patients (e.g., HbA1C every three months) to be evaluated. The two outcome assessments made during the no-treatment period (i.e., O1 and O2) served as a control for each participant, and no significant changes in outcomes were expected during this period (Sidani, 2015). However, significant changes were expected following

the intervention. Because participants had received both the treatment and no-treatment conditions, comparison of the two conditions can be used to demonstrate covariation (Sidani, 2015).

### **5.2.2 Rationale for Quasi-Experimental Design**

Because CCM-based interventions have been shown to be effective, withholding treatment from PCPs (and their patients) would be unethical. Although the quasi-experimental design did not include a control group, the research design aimed to demonstrate causality between the intervention and outcome as in an RCT (Harris et al., 2006).

## **5.3 Intervention**

### **5.3.1 Conceptualization of Intervention**

The CCM was used as the conceptual framework that underpinned the EMR training intervention, as it has been internationally recognized as "the most advanced" in terms of conceptualisation, design, and in the range of evidence supporting it (Ramli et al., 2014, p. 5). There is substantial evidence supporting the use of the CCM and its elements in primary care and various NCDs through systematic reviews (Adams et al., 2007; Coleman et al., 2009; Jacobson & Gance-Cleveland, 2011; Stellefson et al., 2013; Zwar et al., 2006) and meta-analysis (Tsai, Morton, Mangione, & Keeler, 2005). The intervention focused on the "clinical information systems" and "delivery systems design" components of the CCM (i.e., developing and maintaining, registries and

reminders/recalls). This component also aligns with Level 4 (Proactive Care/Data Driven Practice) of BC's Clinical Value Model for EMRs.

### 5.3.2 Video Tutorial Intervention

The study intervention, referred to as MD-PET (Management of Diabetes Post-Implementation EMR Training), was a series of four short online video tutorials that were available for PCPs to view over a period of two to three weeks (Figure 12).

**The Video Tutorial Intervention included how to:**

1. Create and maintain a diabetes registry by coding diabetic patients using the "250" International Classification of Diseases, Ninth Revision (ICD-9) code for diabetes mellitus
2. Create recalls/reminders for diabetes care
3. Order/view Hemoglobin A1C in the EMR
4. Record blood pressure for diabetes care visits in the EMR

**Figure 12 Contents of the Video Tutorial Intervention**

The video tutorials were designed based on best practices in the literature for designing video tutorials for software applications, as recommended by van der Meij & van der Meij (2013). Table 3 provides details of the guidelines from van der Meij & van der Meij (2013) and how they were applied in designing the video tutorials. In total, 12 guidelines were fully applied and three were partially applied.

**Table 3 Application of Video Tutorial Design Guidelines**

<b>Video Tutorial Design Guideline</b> (van der Meij & van der Meij, 2013)	<b>Sub-Guideline</b>	<b>Applied (Yes/No)</b>	<b>How it was Applied</b>
<b>Guideline 1: Provide easy access</b>	Guideline 1.1: Craft the title carefully	Yes	The title of all the video tutorials contain a verb and an object to tell the user what task the video demonstrates how to perform.
	Guideline 2.1: Be faithful to the actual interface in the animation	Yes	The actual interface of OSCAR EMR was captured in the video tutorials using screencasting software.
	Guideline 2.2: Use a spoken human voice for the narration	Yes	The Physician Champion's voice was used for narration.
<b>Guideline 2: Use animation with narration</b>	Guideline 2.3: Action and voice must be in synch	Yes	The Physician Champion's actions and voice were in synch.
	Guideline 3.1: Pace the video carefully	Yes	The Physician Champion kept a conversational tempo and ensured that he did not speak instructions too quickly and included brief pauses.
	Guideline 3.2: Enable user control	Yes	Users were able to start, pause, stop, and replay the videos.
<b>Guideline 3: Enable functional interactivity</b>	Guideline 4.1: Promote the goal	Partial	Users were provided the learning goal for every video. However, users were not provided a preview of the task.
	Guideline 4.2: Use a conversational style to enhance perceptions of task relevance	Yes	The Physician Champion delivered instructional messages in a conversational style.
	Guideline 4.3: Introduce new concepts by showing their use in context	Yes	The video tutorials introduce new related concepts, as needed (e.g., rationale for color coding of measurements)
<b>Guideline 4: Preview the task</b>			

Video Tutorial Design Guideline (van der Meij & van der Meij, 2013)	Sub-Guideline	Applied (Yes/No)	How it was Applied
			after showing users how to record blood pressure).
<b>Guideline 5: Provide procedural rather than conceptual information</b>	N/A	Yes	Presenting procedural (how-to) information was the focus of the video tutorials. Conceptual information was kept to a minimum.
<b>Guideline 6: Make tasks clear and simple</b>	Guideline 6.1: Follow the user's mental plan in describing an action sequence	Yes	The video tutorials follow the sequence in which users generally engage in EMR task execution for diabetes care visits.
	Guideline 6.2: Draw attention to the interconnection of user actions and system reactions	Yes	The video tutorials state the goal or purpose, as well as demonstrate how (i.e., the actions) to achieve the goal.
	Guideline 6.3: Use highlighting to guide attention	Yes	Highlighting of the mouse was used in the video tutorials.
<b>Guideline 7: Keep videos short</b>	N/A	Partial	The length of the video tutorials ranged from 3 minutes and 48 seconds to 4 minutes and 48 seconds. They were slightly longer than the suggested 3-minute average for videos on medical consultation for problem-based learning (van der Meij & van der Meij, 2013).
<b>Guideline 8: Strengthen demonstration with practice</b>	N/A	Partial	To ensure that users watched all the video tutorials in the study intervention, users were instructed to practice the tasks at the end of the final video tutorial only.

With the help of a Physician Champion from the OSCAR BC Users' Group, the researcher created the narrated script for the video tutorials (See Appendix A). The content and topic selection for the video tutorials was determined based on Level 4 functions of BC's Clinical Value Model for EMRs (i.e., use of registries, recalls and reminders) and the BC Clinical Guidelines for diabetes care (i.e., recording blood pressure and ordering of lab tests for HbA1C). The order of the video tutorials was based on proactively planning a follow up diabetes care visit in the EMR for a patient, and aligns with the CCM in terms of developing a patient registry, recalling patients, and viewing and recording process measures for diabetes care. As such, a PCP would first typically create or review their diabetes registry and then create a recall/reminder to see patients for their follow up diabetes care visits. During the diabetes care follow up visit, the PCP typically views and orders lab work for Hemoglobin A1C, and also records the patient's blood pressure in their chart.

To increase homophily (Shachak et al., 2011) between the study population and the video tutorial trainer, the same Physician Champion was recruited to record the video tutorials. After the scripts were finalized, the Physician Champion had then recorded the video tutorials using Camtasia®, a screen-recording software. In addition to the screen, the Physician Champion's face was recorded simultaneously. Because it was the Physician Champion's first time recording video tutorials, each video was recorded two to four times to improve the quality and presentation of the tutorial. During this process, the video tutorial script was further edited to improve the flow of content. Using Camtasia®, the researcher edited and produced the videos, including the addition of animations, mouse highlighting, transitions, music, etc. The link was shared with the Physician

Champion and the researcher's Ph.D. committee (research team) for feedback. Based on the feedback, further edits were made to the video tutorials. The link to the finalized video tutorials was made available to study participants via a private YouTube video link (Randhawa & Yap, 2017) to view at their convenience during the intervention period. Additional details of the study intervention can be seen in Appendix B, including the link to the video tutorials and screen shots.

## **5.4 Setting and Sample**

### **5.4.1 Study Setting**

The study was set in British Columbia, Canada, and included BC's six regions: Vancouver Coastal, Vancouver Island, Fraser, Interior, Northern, and Rural and Remote. In these regions, there are 35 Divisions of Family Practice (DoFP) that represent over 230 communities served by PCPs.

### **5.4.2 Study Participants**

The study participants included PCPs who use the OSCAR EMR. Although there are over nine different EMRs used by PCPs in BC, one of the major EMRs used is OSCAR EMR. In BC, there are approximately 984 PCPs who use OSCAR EMR (B. Hobson, personal communication, September 15, 2016). All PCPs in BC who use the OSCAR EMR were invited to participate in the study. To be considered eligible for enrolment, participants must have been: (a) full-service family physician (FSFP), (b) member of a Division of Family Practice, (c) use the OSCAR EMR, (d) work in a solo or

group practice, (e) have diabetic patients in their practice, and (f) be interested in implementing and applying the intervention in their practice, including using the advanced features of their EMR for diabetes care. OSCAR EMR users who were locum physicians or from outside of BC were excluded from the study.

Human research ethics approval was obtained from the University of Victoria Human Research Ethics Board (Ethics Protocol # 17-189).

## **5.5 Recruitment of Participants**

An a-priori sample size calculation in the G\*Power computer program (Faul & Erdfelder, 1998) indicated that a total sample of 24 participants would be needed to detect medium effects ( $f(U) = .25$ ) with 80% power using repeated measures analysis of variance (rANOVA) with alpha at .05. Given the barriers to engaging PCPs in research (especially lack of funding to compensate physician time), the study used a convenience sample. All eligible and interested PCPs who use the OSCAR EMR were invited to participate in the study.

Following ethics and operational approvals, all study participants were recruited through the Divisions of Family Practice and OSCAR BC Users' Group using (a) an invitation letter (see Appendix C), (b) a YouTube video that explained the research study (Randhawa, 2017b), and (c) a study consent form (see Appendix D). The Divisions of Family Practice advertised the study opportunity to their division members through several ways, including emails, newsletters, division meetings, and word of mouth.

Eligible PCPs who expressed interest in participating in the study were included in the study on a "first come, first served" basis. Following the initial invitation, reminders were sent to those PCPs who had not responded. Study recruitment took place between July to October 2017.

## 5.6 Data Collection

Qualitative and quantitative data were collected between July 2017 to May 2018. The research questions were addressed using the data collection methods and time phases outlined in Table 4 below.

**Table 4 Data Collection Methods by Study Time/Phase**

Time/Phase	Data Collection Method/Tool	Research Question
Pre-intervention	PCP Demographic Questionnaire (O1) and appended Diabetes Care Questionnaire (O1)	<b>Research Questions #1:</b> To what extent does the intervention demonstrate the potential to improve process measures for type 1 and type 2 diabetes care management?
Post-Intervention	Diabetes Care Questionnaire (O2, O3, O4)	<b>Research Questions #3:</b> What are the relationships between the personal characteristics of PCPs who are interested in improving their EMR use for diabetes care?  <b>Research Question #4:</b> To what extent do individual PCP characteristics relate to EMR use for diabetes care?
	Follow-Up Interviews (O3 and O4)	<b>Research Question #2:</b> What are the barriers and facilitators to applying the CCM-based post-implementation EMR training into PCPs' practice?

## **5.6.1 Data Collection Methods**

### **5.6.1.1 PCP Demographic Questionnaire**

To answer research questions 1, 3, and 4, a demographic survey and Diabetes Care Questionnaire were used (See Appendix E). PCPs were first asked to complete a demographic survey prior to the intervention (O1). The PCP Demographic Questionnaire was designed by the researcher and included questions related to PCPs' age, gender, location of practice, years of practice, type of practice, years of EMR experience, number of EMRs used, prior post-implementation EMR training, and a self-assessment of general computer skills and EMR skills. Questions about PCPs' ordering practices for Hemoglobin A1C and frequency of measuring blood pressure for diabetic patients were also included in the PCP Demographic Questionnaire.

### **5.6.1.2 Diabetes Care Questionnaire**

Data on PCPs' process measures were collected from a Diabetes Care Questionnaire that was completed by the participants for one month before (O1), immediately before (O2), three months after (O3), and six months after the intervention (O4). The questionnaire was developed in May 2017 by the research team and assessed for face validity. To increase content validity, the Diabetes Care questionnaire uses the concept of specific EMR metric percentages, as outlined in the Objective Data Dashboard (ODD) Metrics for PCP's achievement of Meaningful Use Level 3 (Practice Support Program, n.d.). While the ODD calculates EMR feature usage metrics through a ratio

(i.e., a numerator and denominator) that is pulled from the PCP's EMR, the Diabetes Care Questionnaire requires PCPs to self-report this information.

The Diabetes Care Questionnaire was administered electronically using Simple Survey® (Oustide Soft Solutions, 2018), an online survey software for data collection and analysis. The questions from the Diabetes Care Questionnaire are outlined below:

1. Overall for what percentage of your diabetic patients do you routinely assign the “250” ICD code in the patient’s problem list in the EMR **to ensure that your patients can be identified as patients with diabetes?**
2. For what percentage of your **stable** diabetic patients do you routinely assign the "250" ICD-9 code in the EMR for nearly all or all diabetes follow up visits?
3. For what percentage of your **unstable** diabetic patients do you routinely assign the "250" ICD-9 code in the EMR for nearly all or all diabetes follow up visits?
4. For what percentage of your **stable** diabetic patients:
  - a. Have you ever created a diabetes recall/reminder?
  - b. Do you order/view Hemoglobin A1C in the EMR at all or nearly all diabetes follow-up visits?
  - c. Do you record blood pressure in the EMR at all or nearly all diabetes follow-up visits?
5. For what percentage of your **stable** diabetic patients:
  - a. Have you ever created a diabetes recall/reminder?
  - b. Do you order/view Hemoglobin A1C in the EMR at all or nearly all diabetes follow-up visits?

- c. Do you record blood pressure in the EMR at all or nearly all diabetes follow-up visits?
6. Please feel free to share any **comments** regarding your use of the EMR for diabetes care management.

### **5.6.1.3 Follow up Interviews**

To answer research question 2, "What are the barriers and facilitators to applying the CCM-based post-implementation EMR training into PCPs' practice?," semi-structured follow-up interviews were conducted by phone with interested study participants at three and six months after the intervention (O3 and O4). PCPs who participated in the follow-up interviews at three months (O3) were not excluded from participating in the follow-up interviews at six months (O4). The interview guides used at O3 and O4 can be seen in Appendix F. Interviews were audio-recorded using Camtasia® and transcribed verbatim by the researcher.

### **5.6.2 Variables and Data Collection**

Variables that were collected through these data collection methods are outlined in Table 5 below, including the corresponding data source/method and data collection time point.

**Table 5 Variables Collected for Research Questions 1 and 2**

<b>Variable</b>	<b>Definition</b>	<b>Data Type</b>	<b>How it will be Measured</b>	<b>Data Source</b>	<b>Data Collection Time Point</b>	<b>Research Question #</b>
Age group	N/A	Ordinal	Self-reported	PCP Demographic Questionnaire	O1	1, 3, 4
Sex	N/A	Categorical	Self-reported	PCP Demographic Questionnaire	O1	1, 3, 4
Health Authority/ Location of Practice	The Health Authority in which the PCP's practice is located.	Categorical	See definition.	PCP Demographic Questionnaire	O1	1, 3, 4
Years of Practice	The number of years the PCP has been in practice since their residency.	Ordinal	See definition.	PCP Demographic Questionnaire	O1	1, 3, 4
Type of practice (solo or multi-PCP)	The type of practice in which a PCP practices (e.g., solo or multi-PCP office).	Categorical	See definition.	PCP Demographic Questionnaire	O1	1, 3, 4
Years of EMR Experience	The number of years a PCP has used an EMR.	Ordinal	See definition.	PCP Demographic Questionnaire	O1	1, 3, 4
Number of EMRs used	The number of EMRs a PCP has used since they started practicing medicine.	Interval	See definition.	PCP Demographic Questionnaire	O1	1, 3, 4
Prior Post-implementation EMR training	Previous PCP participation in post-implementation EMR training.	Categorical	See definition.	PCP Demographic Questionnaire	O1	1, 3, 4
Computer Skills	Self-assessment of general computer skills.	Ordinal	See definition.	PCP Demographic Questionnaire	O1	1, 3, 4
EMR Skills	Self-assessment of EMR skills	Ordinal	See definition.	PCP Demographic Questionnaire	O1	1, 3, 4
Ordering Hemoglobin A1C for stable diabetic Patients	PCP's frequency of ordering Hemoglobin A1C for stable diabetic patients.	Ordinal	See definition.	PCP Demographic Questionnaire	O1	1
Ordering Hemoglobin A1C for	PCP's frequency of ordering Hemoglobin	Ordinal	See definition.	PCP Demographic Questionnaire	O1	1

<b>Variable</b>	<b>Definition</b>	<b>Data Type</b>	<b>How it will be Measured</b>	<b>Data Source</b>	<b>Data Collection Time Point</b>	<b>Research Question #</b>
unstable diabetic patients	A1C for unstable diabetic patients.					
Recording blood pressure for stable diabetic patients	PCP's frequency of measuring blood pressure for stable diabetic patients.	Ordinal	See definition.	PCP Demographic Questionnaire	O1	1
Recording blood pressure for unstable diabetic patients	PCP's frequency of measuring blood pressure for unstable diabetic patients.	Ordinal	See definition.	PCP Demographic Questionnaire	O1	1
Time	The time before or after the intervention	Ordinal	See definition.	N/A	O1-O4	1, 2
Diabetes Registry	The creation and maintenance of a diabetes registry using ICD-9 coding to identify diabetic patients.	Interval	Percentage of diabetic patients with a "250" ICD-9 code in the problem list.	Diabetes Care Questionnaire	O1-O4	1
Stable Diabetes Follow Up Visit ICD-9 Coding	The routine assignment of "250" ICD-9 code in the EMR for stable diabetic patients for nearly all or all diabetes follow up visits.	Interval	Percentage of stable diabetic patients with a "250" ICD-9 code for nearly all or all diabetes follow up visits.	Diabetes Care Questionnaire	O1-O4	1
Unstable Diabetes Follow Up Visit ICD-9 Coding	The routine assignment of "250" ICD-9 code in the EMR for unstable diabetic patients for nearly all or all diabetes follow up visits.	Interval	Percentage of unstable diabetic patients with a "250" ICD-9 code for nearly all or all diabetes follow up visits.	Diabetes Care Questionnaire	O1-O4	1
Recall	Stable diabetic	Interval	Percentage	Diabetes Care	O1-O4	1

<b>Variable</b>	<b>Definition</b>	<b>Data Type</b>	<b>How it will be Measured</b>	<b>Data Source</b>	<b>Data Collection Time Point</b>	<b>Research Question #</b>
Reminders for Stable Diabetic Patients	patients who have ever had a documented diabetes recall reminder.		of stable diabetic patients who have ever had a documented diabetes recall reminder.	Questionnaire		
Recall Reminders for Unstable Diabetic Patients	Unstable diabetic patients who have ever had a documented diabetes recall reminder.	Interval	Percentage of unstable diabetic patients who have ever had a documented diabetes recall reminder.	Diabetes Care Questionnaire	O1-O4	1
Hemoglobin A1C for Stable Diabetic Patients	Stable diabetic patients who have had Hemoglobin A1C ordered/viewed at all or nearly all diabetes follow-up visits.	Interval	Percentage of stable diabetic patients have had Hemoglobin A1C ordered/viewed at all or nearly all diabetes follow-up visits.	Diabetes Care Questionnaire	O1-O4	1
Hemoglobin A1C for Unstable Diabetic Patients	Unstable diabetic patients who have had Hemoglobin A1C ordered/viewed at all or nearly all diabetes follow-up visits.	Interval	Percentage of unstable diabetic patients have had Hemoglobin A1C ordered/viewed at all or nearly all diabetes follow-up visits.	Diabetes Care Questionnaire	O1-O4	1
Blood Pressure recorded for Stable	Stable diabetic patients who have had a blood pressure	Interval	Percentage of stable diabetic patients who	Diabetes Care Questionnaire	O1-O4	1

<b>Variable</b>	<b>Definition</b>	<b>Data Type</b>	<b>How it will be Measured</b>	<b>Data Source</b>	<b>Data Collection Time Point</b>	<b>Research Question #</b>
Diabetic Patients	recorded in the EMR at all or nearly all diabetes follow-up visits.		have had a blood pressure recorded in the EMR at all or nearly all diabetes follow-up visits.			
Blood Pressure recorded for Unstable Diabetic Patients	Unstable diabetic patients who have had a blood pressure recorded in the EMR at all or nearly all diabetes follow-up visits.	Interval	Percentage of unstable diabetic patients who have had a blood pressure recorded in the EMR at all or nearly all diabetes follow-up visits.	Diabetes Care Questionnaire	O1-O4	1
MCEU1	Composite score for usage of diabetes care features at O1.	Interval	Sum of all EMR features used at O1 divided by 4.	Diabetes Care Questionnaire	Calculated at O4	1, 3, 4
MCEU2	Composite score for usage of diabetes care features at O2.	Interval	Sum of all EMR features used at O2 divided by 4.	Diabetes Care Questionnaire	Calculated at O4	1
MCEU3	Composite score for usage of diabetes care features at O3.	Interval	Sum of all EMR features used at O3 divided by 4.	Diabetes Care Questionnaire	Calculated at O4	1
MCEU4	Composite score for usage of diabetes care features at O4.	Interval	Sum of all EMR features used at O4 divided by 4.	Diabetes Care Questionnaire	Calculated at O4	1

Due to the limited post-intervention study timeline (i.e., six months), other clinical indicators in the BC guidelines for Diabetes Care (e.g., eye exam, foot exam, pneumovax) that are assessed annually were not examined as part of this study.

## 5.7 Data Analysis

The data analysis methods for all research data are outlined in Table 6 below, followed by a description of each data analysis method.

**Table 6 Data Analysis Methods**

<b>Data Analysis Method</b>	<b>Data Collection Method</b>	<b>Research Question</b>
<b>Descriptive Statistics</b>	PCP Demographic Questionnaire (O1)	1, 2, 3, 4
	Diabetes Care Questionnaire (O1, O2, O3, O4)	1, 2
<b>Kendall's tau-b Correlation</b>	Diabetes Care Questionnaire	3
<b>Pearson's Correlation</b>	Diabetes Care Questionnaire	3
<b>Independent Samples t-tests</b>	Diabetes Care Questionnaire	3
<b>Multiple Linear Regression</b>	Diabetes Care Questionnaire	4
<b>Repeated Measures Analysis of Variance (rANOVA)</b>	Diabetes Care Questionnaire	1, 2
<b>Mixed Analysis of Variance (Mixed ANOVA) with Repeated Measures</b>	Diabetes Care Questionnaire	4
<b>Thematic Analysis</b>	Diabetes Care Questionnaire	1
	Follow-Up Interviews	2

### 5.7.1 Quantitative Data Analysis

#### 5.7.1.1 Descriptive Statistics

Descriptive statistics (frequencies) from the PCP Demographic Survey and Diabetes Care Questionnaire were used to describe the participant characteristics. The

means, medians, modes, ranges, and standard deviations were also calculated for data from the Diabetes Care Questionnaire. Data trends were illustrated graphically for each process measure (i.e., (a) use of a diabetes registry, (b) use of diabetes recalls/reminders, (c) ordering/viewing a patient's HbA1C every 3-6 months, and (d) recording a patient's blood pressure every 3-6 months across the different data collection points.

#### **5.7.1.2 Pearson's Correlation and Kendall's tau-b**

To study the relationships between various PCP characteristics, Kendall's tau-b correlation coefficients were calculated for the following ordinal variables: age group, years of practice, years of EMR experience, computer skills, and EMR skills. To study relationships between PCP characteristics and PCPs' baseline use of the EMR for diabetes care, Pearson's and Kendall's tau-b correlation coefficients were used for interval and ordinal variables, respectively.

#### **5.7.1.3 Independent Samples T-Tests**

Differences in baseline use of the EMR and sex, health authority, and prior post-implementation EMR training of the PCPs were tested using independent sample t-tests.

#### **5.7.1.4 Multiple Linear Regression**

To further examine the effects of PCP characteristics on PCPs' use of EMR features for diabetes care at baseline (O1), multiple linear regression was used. To decrease multicollinearity, only selected PCP characteristics (i.e., years of practice, EMR skills, and prior post-implementation training) were included if they correlated with other

PCP characteristics. Descriptive statistics were used to analyze the effects of PCP characteristics on their use of EMR features for diabetes care over time.

#### **5.7.1.5 Repeated Measures Analysis of Variance (rANOVA)**

To determine the difference between the pre-intervention and post-intervention observations (O1, O2, O3, and O4), analysis of variance with repeated measures (rANOVA) was used with post-hoc tests. Initially, rANOVA assumptions were tested for every dependent variable (i.e., each process measure). However, because the dependent variables did not meet the sphericity assumptions for rANOVA (i.e., Mauchly's test of sphericity indicated that the assumption of sphericity had been violated,  $\chi^2(2) = 23.30, p < .001$ ), a statistician from the University of Victoria was consulted.

Given the conceptual similarity of the nine dependent variables (i.e., all are process measures for diabetes care that were measured using the same scale), they were combined to create a composite variable called "MCEU" at each time point (i.e. O1-O4). A composite variable is "a variable made up of two or more variables or measures that are highly related to one another conceptually or statistically" (Ley, 1972). Creating composite variables is common practice in the social and health sciences (MacDonald, 2018), especially when the sample size is not large enough to test multiple comparisons (Song, Lin, Ward, & Fine, 2013), as in this research study. Given that all the process measures were continuous variables, the "averaging" method was used to create the four composite variables (i.e., "MCEU1", "MCEU2", "MCEU3" and "MCEU4"). To assess the reliability (i.e., internal consistency) of this new scale, Cronbach's alpha and McDonald's omega (MacDonald, 2018) were calculated, as outlined in Table 7. The

composite variables had "good" internal consistency. The composite variables met all four assumptions necessary to conduct rANOVA.

**Table 7 Reliability Analysis of Composite Variables**

	Mean	SD	McDonald's $\omega$	Cronbach's $\alpha$	Average Inter-Item correlation
<b>scale</b>	75.18	5.542	0.815	0.808	0.521

### **5.7.1.6 Two-Way Mixed Analysis of Variance (Mixed ANOVA) with Repeated Measures**

To assess the effects of physician characteristics on pre-intervention and post-intervention observations, mixed ANOVAs with repeated measures were used, followed by post-hoc tests.

### **5.7.1.7 Quantitative Analysis Software**

Quantitative data analysis was performed using JASP Version 0.9 (JASP Team, 2018) and then repeated using IBM SPSS Statistics Version 24 (IBM, 2016) to confirm the calculations. G\*Power (Buchner, Erdfelder, Faul, & Lang, 2014) was used for a-priori and post-hoc calculations for sample size and observed power, respectively.

## **5.7.2 Qualitative Data Analysis**

Qualitative data from free-text comments in the Diabetes Care Questionnaire and follow-up interviews were analyzed using **thematic analysis**. Thematic analysis allows themes within the data to be identified (Priest, Roberts, & Woods, 2002) through the

systematic process of coding, sorting, and interpreting data (Liamputtong & Ezzy, 2005). The four steps of thematic data analysis were followed, including: (1) immersion, (2) coding, (3) categorizing, and (4) generation of themes (Green et al., 2007).

Immersion included the repeated reading and re-reading of the qualitative data (i.e., follow-up interview responses) (Green et al., 2007). As such, immersion had laid the foundation for connecting data elements into a clearer picture of the topic under investigation (Green et al., 2007). Following immersion, coding was central to the analysis process (Liamputtong & Ezzy, 2005) and is essentially a rigorous taxonomic process of sorting and tagging data (Green et al., 2007).

Using NVivo Version 10 (QSR International Pty Ltd., 2012), the qualitative data were reviewed and coded. Essentially, pieces of text were coded (referred to as "chunks") using open coding (i.e., codes emerged while reading the transcripts). The coding scheme was refined and extended while reviewing the transcripts. The final coding scheme can be seen in Appendix G. Chunks that were coded in the same way were then collated (Liamputtong & Ezzy, 2005). Trustworthiness of the coding was established as described below.

After coding, the next step in thematic analysis was categorization, which involved linking the codes to create coherent categories (Green et al., 2007). The goal of categorization was to find a "good fit" between codes that share a relationship (Green et al., 2007). The final step in analyzing the qualitative data had involved the identification of themes. Themes are distinct from categories, as they provide an explanation or interpretation of the issue under investigation (Green et al., 2007).

The trustworthiness of the qualitative data was established by addressing the four constructs of a trustworthy study (Guba, 1981): (1) credibility (the qualitative equivalent of internal validity), (2) transferability (the qualitative equivalent of external validity/generalizability), (3) dependability (the qualitative equivalent of reliability), and (4) confirmability (the qualitative equivalent of objectivity). To establish trustworthiness and verify the coding, a subset of the data was coded by two researchers (the author of this thesis and a PhD-qualified researcher) to check agreement. Fourteen percent of the PCP interviews and 10% of the qualitative comments from the Diabetes Care questionnaires were double-coded. To support verification of the codes, the second researcher was provided the study code book (Appendix G) and encouraged to add additional codes, as needed. The second researcher coded the data at the highest node level and there was moderately high agreement (77%) between the coders. Disagreements were related to detailed codes that were not used by the second researcher. To resolve discrepancies and reach consensus, the more detailed code was used.

To establish credibility, the researcher had engaged in *frequent debriefing sessions* with her Ph.D. Supervisory Committee members (Shenton, 2004). In addition, the researcher had *examined previous research findings* to assess the extent to which the qualitative data findings align with past research findings (Shenton, 2004).

Transferability of the qualitative data findings was established through numerous data collection points (four for the qualitative data from the DCM Questionnaire and two points for the interviews at O3 and O4). To demonstrate dependability, the study methods have been reported in detail, enabling future researchers to repeat the study and potentially find the same results (Shenton, 2004). The reporting includes details of the

research design and its implementation and the operational details of data gathering (Shenton, 2004). For confirmability, the researcher developed and maintained analytic memos to aide in the monitoring and evolution of themes (Shenton, 2004).

### **5.7.3 Interpretation of Quantitative and Qualitative Data**

Quantitative and qualitative data analyses were initially conducted separately. However, findings were interpreted by corroborating quantitative and qualitative findings. As a part of QUAN(qual) mixed methods design, quantitative data findings were identified as the main data source to determine the efficacy of MD-PET. Qualitative findings were used to supplement and explain the quantitative findings (i.e., explain the efficacy of the video tutorials).

## **Chapter 6: Results**

### **6.1 Participants**

#### **6.1.1 Response Rate**

A total of 23 PCPs responded to the call for participation, and provided their participant consent forms. While all of these PCPs participated in the first data collection point (O1), five did not respond at the O2 data collection point or receive MD-PET. These PCPs were not invited to participate in subsequent data collection. In total, 18 PCPs participated in the full study (i.e., data collection points O1-O4), and submitted complete data for the Diabetes Care Questionnaire (i.e., there were no missing data). Of these participants, 12 (67%) participated in follow-up interviews at O3, and nine (50%) participated in follow-up interviews at O4. Seven PCPs (39%) participated in both the O3 and O4 follow-up interviews.

#### **6.1.2 Demographics**

The participant demographics are summarized in Table 12 below. The majority of participants were women (n=12; 67%), 45-64 years old (n=14; 78%), from Vancouver Island, BC (n=12; 67%), worked in a multi-physician clinic (n=16; 89%), and had been practicing medicine for over 20 years (n=12; 67%). Almost half (n=8; 44%) of participants had used OSCAR EMR for 5-9 years, while 39% (n=7) had used it for 3-4 years. Most participants (n=7; 38%) had used two EMRs, while a third (n=6; 33%) of participants had used only one EMR (i.e., OSCAR EMR). The average number of EMRs used was two. Half (n=9; 50%) of the participants had received prior post-

implementation training. The majority of participants reported their computer skills and EMR skills as average (n=10, 56% and n=12; 67%, respectively). In terms of frequency of ordering HbA1C for patients with diabetes at baseline, half (n=9; 50%) of participants reported ordering HbA1C for their stable patients every three months, while all (n=18; 100%) participants order HbA1C for their unstable patients every three months. The majority of participants measure blood pressure in their stable and unstable patients with diabetes every three months (n=11; 61% and n=14; 78%, respectively).

**Table 12 Participant Demographics**

<b>Demographic</b>	<b>No. of Participants (n=18)</b>	<b>Percentage of Participants</b>
<b>Age Group</b>		
35-44	3	16.7
45-54	7	38.9
55-64	7	38.9
65+	1	5.6
<b>Sex</b>		
Male	6	33.3
Female	12	66.7
<b>Health Authority/Location</b>		
Fraser Valley	5	27.8
Vancouver Coastal	1	5.6
Vancouver Island	12	66.7
<b>Years of Practice</b>		
<4	3	16.7
5-9	0	0.0
10-14	1	5.6
15-19	2	11.1
20+	12	66.7
<b>Type of Practice</b>		
Multi-Physician	16	88.9
Solo	2	11.1
<b>Years of EMR Experience</b>		
1-2	1	5.6
3-4	7	38.9

<b>Demographic</b>	<b>No. of Participants (n=18)</b>	<b>Percentage of Participants</b>
5-9	9	50.0
10-14	1	5.6
<b>Years of Experience using OSCAR EMR</b>		
1-2	1	5.6
3-4	7	38.9
5-9	8	44.4
10-14	1	5.6
<b>Number of EMRs Used</b>		
1	6	33.3
2	7	38.9
3	3	16.7
4	2	11.1
<b>Prior Post-Implementation Training</b>		
Yes	9	50.0
No	9	50.0
<b>Computer Skills</b>		
Low	3	16.7
Average	10	55.6
Above Average	4	22.2
High	1	5.6
<b>EMR Skills</b>		
Low	1	5.6
Average	12	66.7
Above Average	4	22.2
High	1	5.6
<b>Frequency of Ordering HbA1C for <u>stable</u> diabetic patients</b>		
Every 3 months	9	50.0
Every 3-6 months	1	5.6
Every 6 months	7	38.9
Every year	1	5.6
<b>Frequency of Ordering HbA1C for <u>unstable</u> diabetic patients</b>		
Every 3 months	18	100.0
<b>Frequency of measuring blood pressure for <u>stable</u> diabetic patients</b>		
Every month	1	5.6
Every 3 months	11	61.1
Every 6 months	5	27.8
Every year	1	5.6
<b>Frequency of measuring blood pressure for <u>unstable</u> diabetic patients</b>		
Every month	2	11.1
Every 6 weeks	1	5.6

Demographic	No. of Participants (n=18)	Percentage of Participants
Every 3 months	14	77.8
Every 6 months	1	5.6

## 6.2 Quantitative Results

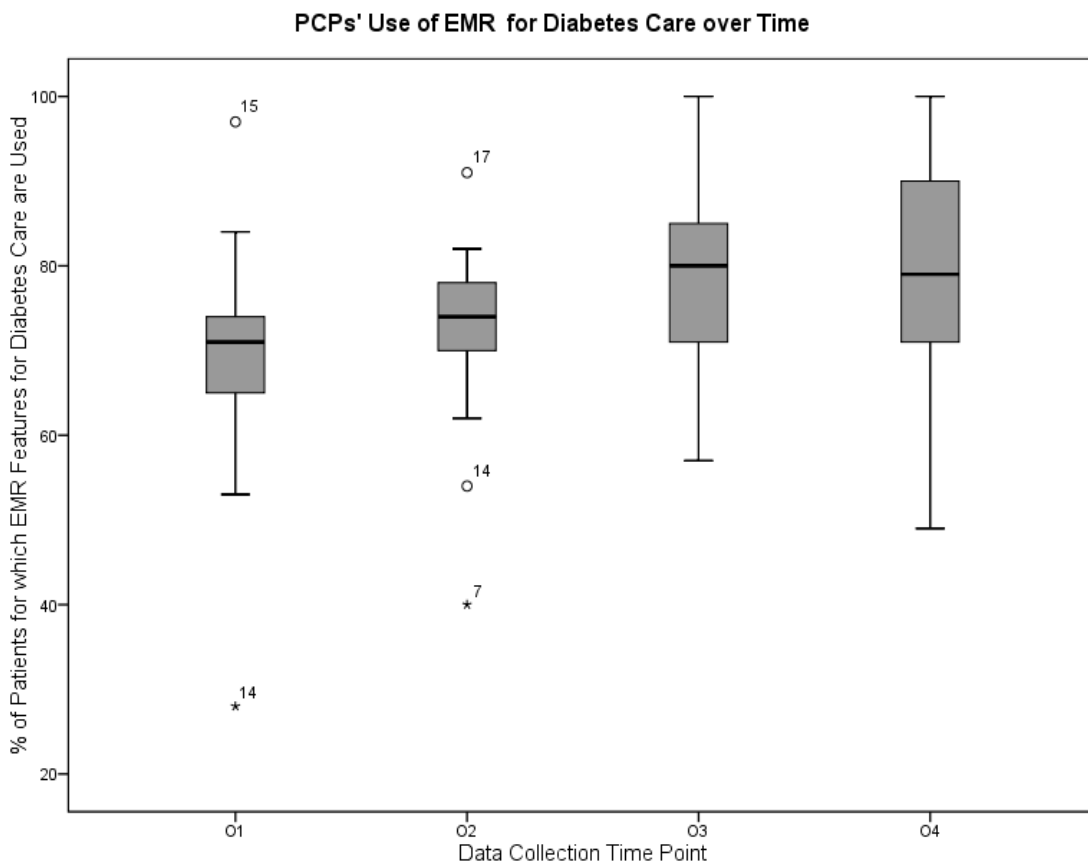
### 6.2.1 Descriptive Statistics and Graphical Trends in EMR Use for Diabetes

The means, medians, modes, standard deviations, and ranges for the composite EMR use scores (i.e., MCEU) across the four study time points can be seen in Table 13. MCEU scores increased from O1 ( $M = 68.78$ ,  $SD = 14.05$ ) to O2 ( $M = 72.33$ ,  $SD = 11.25$ ), O3 ( $M = 79.44$ ,  $SD = 11.66$  mg/L), and O4 ( $M = 80.17$ ,  $SD = 14.39$  mg/L), in that order. The boxplot for each time point can be seen in Figure 13.

**Table 13 Composite EMR Feature Use for Diabetes Care across Time Points**

	MCEU at O1	MCEU at O2	MCEU at O3	MCEU at O4
<b>Mean</b>	68.78	72.33	79.44	80.17
<b>Median</b>	71.00	74.00	80.00	79.00
<b>Mode</b>	71.00 <sup>a</sup>	74.00	71.00 <sup>a</sup>	79.00
<b>Std. Deviation</b>	14.05	11.25	11.66	14.39
<b>Range</b>	69.00	51.00	43.00	51.00
<b>Minimum</b>	28.00	40.00	57.00	49.00
<b>Maximum</b>	97.00	91.00	100.0	100.0

<sup>a</sup> More than one mode exists, only the first is reported



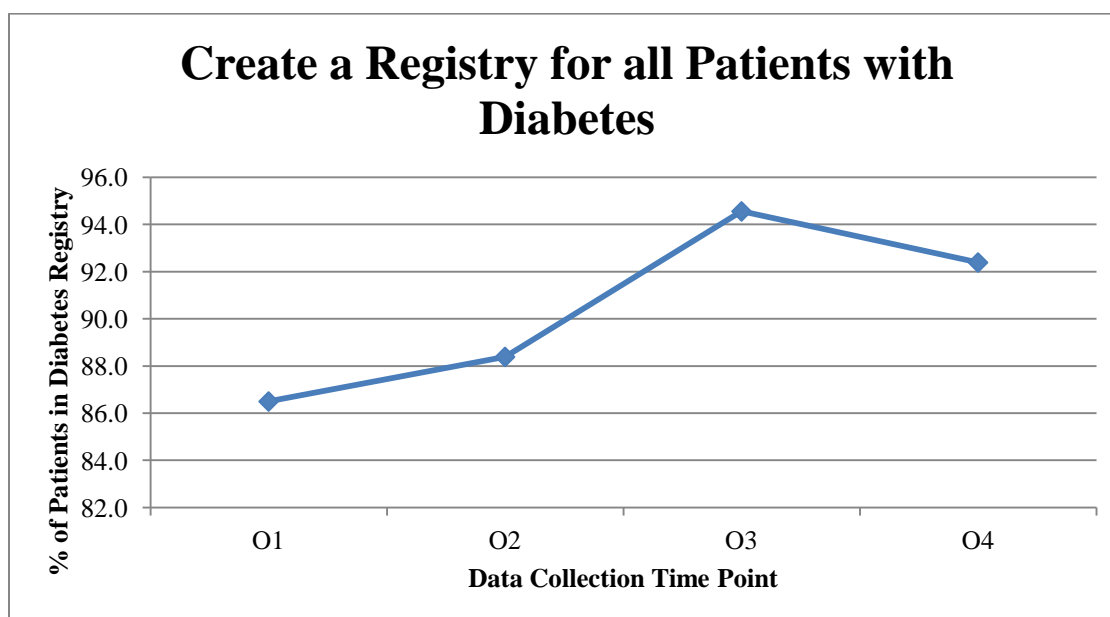
**Figure 13** Boxplot for PCPs' Mean Composite EMR Use (MCEU) score for Diabetes Care over Time

It is also valuable to view the trends in the data across process measures both in tabular and graphical form. The means, medians, modes, standard deviations, and ranges for the individual process measures, which make up the MCEU score, across the study time points can be seen in Tables 14-22, and the graphs can be seen in Figures 14-22. In general, several process measures (i.e., use of the diabetes-related EMR features) increase in a positive direction over the four data collection time points. However, some process measures slightly decreased from O3 to O4, such as creating a diabetes registry for stable and unstable patients with diabetes. Recording blood pressure for unstable patients with diabetes also decreased from O2 to O3, and then increased at O4. The two process

measures that slightly declined from O1 to O4 include ordering lab work for stable and unstable patients with diabetes.

**Table 14 PCP Average Use of Registry for Diabetic Patients over Time**

	<b>Use of Diabetes Registry at O1</b>	<b>Use of Diabetes Registry at O2</b>	<b>Use of Diabetes Registry at O3</b>	<b>Use of Diabetes Registry at O4</b>
<b>Mean</b>	86.50	88.39	94.56	92.39
<b>Median</b>	96.50	99.00	99.50	99.00
<b>Mode</b>	100.0	100.0	100.0	100.0
<b>Std. Deviation</b>	25.75	27.44	11.87	20.89
<b>Range</b>	100.0	100.0	50.00	90.00
<b>Minimum</b>	0.000	0.000	50.00	10.00
<b>Maximum</b>	100.0	100.0	100.0	100.0



**Figure 14 PCPs' Average Use of Registry for Patients with Diabetes over Time**

Table 15 PCPs' Average Use of Registry for Stable Diabetic Patients over Time

	Use of Diabetes Registry at O1	Use of Diabetes Registry at O2	Use of Diabetes Registry at O3	Use of Diabetes Registry at O4
<b>Mean</b>	81.67	83.50	89.39	88.06
<b>Median</b>	90.00	99.50	90.00	98.00
<b>Mode</b>	100.0	100.0	90.00	100.0
<b>Std. Deviation</b>	26.35	28.72	12.19	21.54
<b>Range</b>	100.0	100.0	50.00	90.00
<b>Minimum</b>	0.000	0.000	50.00	10.00
<b>Maximum</b>	100.0	100.0	100.0	100.0

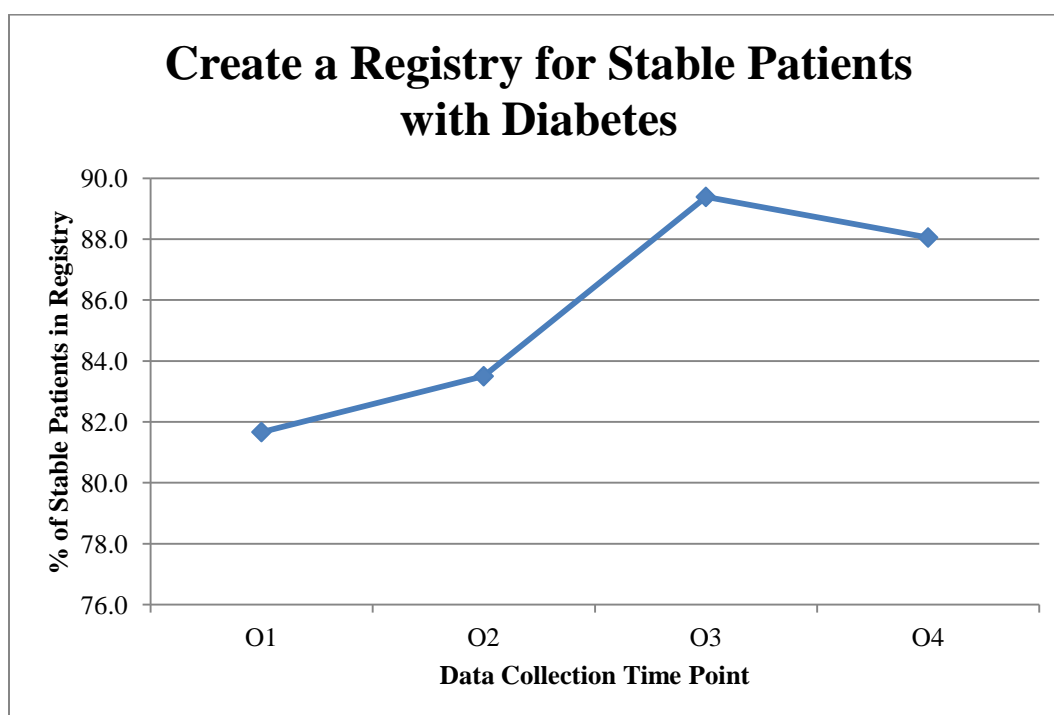


Figure 15 PCPs' Average Use of Registry for Stable Patients with Diabetes over Time

Table 16 PCPs' Average Use of Registry for Unstable Patients with Diabetes over Time

	Use of Diabetes Registry at O1	Use of Diabetes Registry at O2	Use of Diabetes Registry at O3	Use of Diabetes Registry at O4
<b>Mean</b>	84.67	88.78	93.22	93.06
<b>Median</b>	97.00	100.0	99.00	100.0
<b>Mode</b>	100.0	100.0	100.0	100.0
<b>Std. Deviation</b>	26.45	25.54	11.95	20.99
<b>Range</b>	100.0	100.0	50.00	90.00
<b>Minimum</b>	0.000	0.000	50.00	10.00
<b>Maximum</b>	100.0	100.0	100.0	100.0

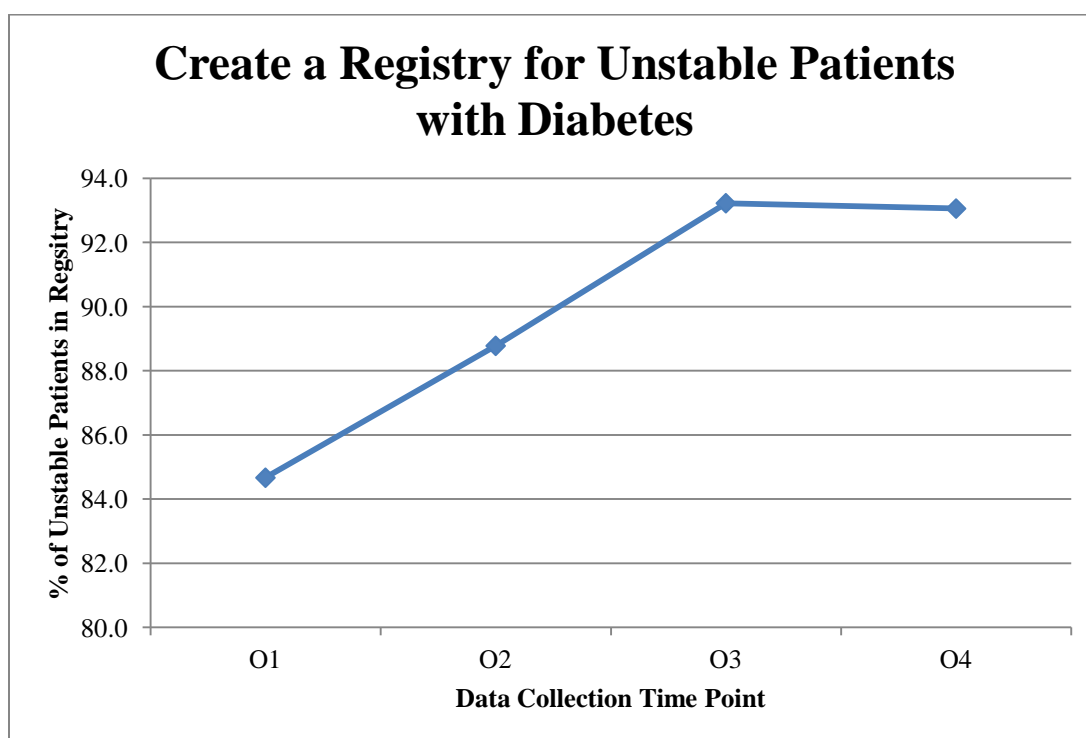


Figure 16 PCPs' Average Use of Registry for Unstable Patients with Diabetes over Time

Table 17 PCPs' Average Use of Recalls for Stable Patients with Diabetes Over Time

	Use of Recalls at O1	Use of Recalls at O2	Use of Recalls at O3	Use of Recalls at O4
<b>Mean</b>	10.83	15.83	34.56	37.50
<b>Median</b>	0.000	5.000	22.50	30.00
<b>Mode</b>	0.000	0.000	0.000	0.000
<b>Std. Deviation</b>	26.86	26.47	37.15	37.31
<b>Range</b>	90.00	100.0	100.0	100.0
<b>Minimum</b>	0.000	0.000	0.000	0.000
<b>Maximum</b>	90.00	100.0	100.0	100.0

<sup>a</sup> More than one mode exists, only the first is reported

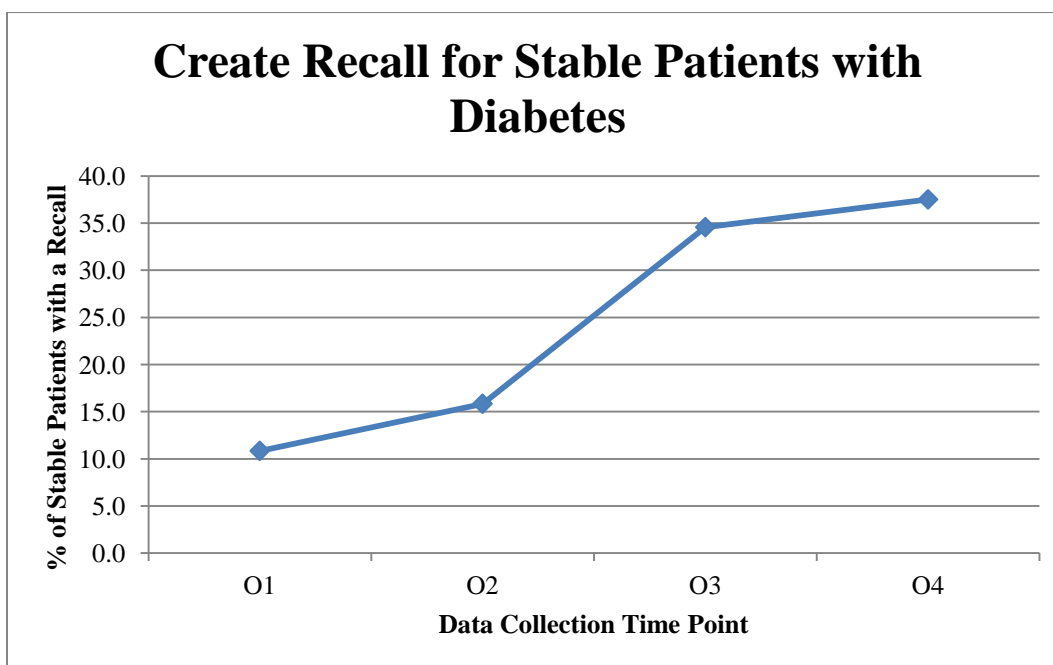


Figure 17 PCP Use of Recalls for Stable Patients with Diabetes Over Time

Table 18 PCPs' Average Use of Recalls for Unstable Patients with Diabetes Over Time

	Use of Recalls at O1	Use of Recalls at O2	Use of Recalls at O3	Use of Recalls at O4
<b>Mean</b>	13.61	21.39	47.61	53.06
<b>Median</b>	0.000	20.00	49.50	50.00
<b>Mode</b>	0.000	0.000	0.000	100.0
<b>Std. Deviation</b>	28.01	27.43	40.46	41.13
<b>Range</b>	90.00	90.00	100.0	100.0
<b>Minimum</b>	0.000	0.000	0.000	0.000
<b>Maximum</b>	90.00	90.00	100.0	100.0

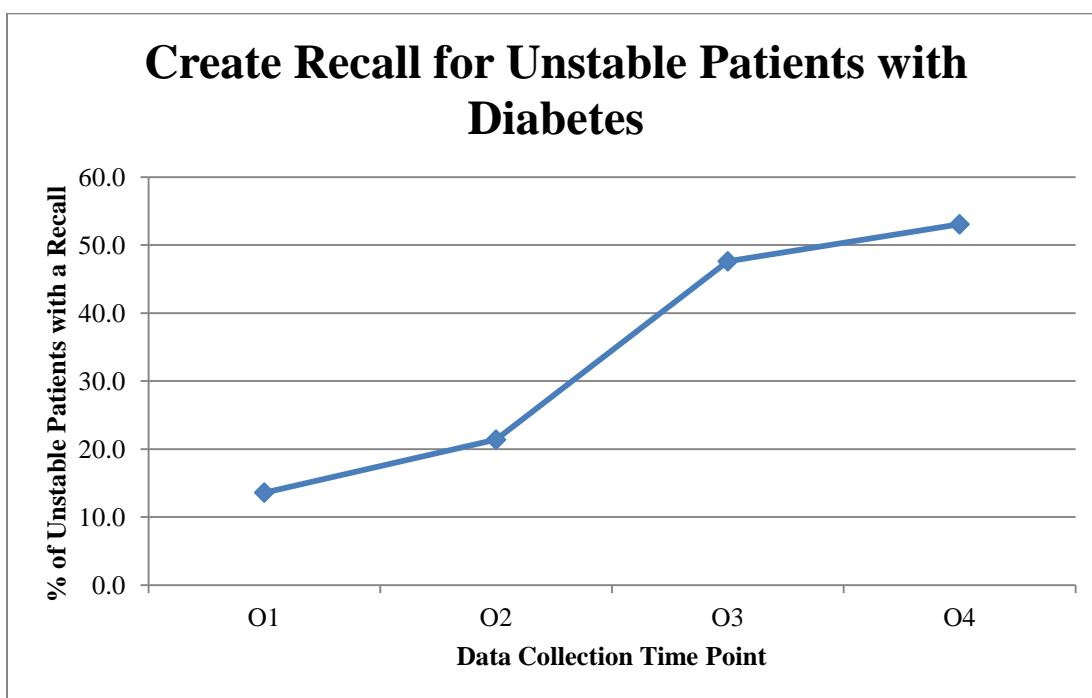


Figure 18 PCP Use of Recalls for Unstable Diabetic Patients Over Time

Table 19 PCPs' Ordering of Lab Work for Stable Patients with Diabetes over Time

	Ordering Lab Work at O1	Ordering Lab Work at O2	Ordering Lab Work at O3	Ordering Lab Work at O4
<b>Mean</b>	90.78	88.56	91.06	88.06
<b>Median</b>	95.00	90.00	95.00	98.50
<b>Mode</b>	100.0	90.00	100.0	100.0
<b>Std. Deviation</b>	12.94	12.53	12.63	25.14
<b>Range</b>	50.00	50.00	50.00	100.0
<b>Minimum</b>	50.00	50.00	50.00	0.000
<b>Maximum</b>	100.0	100.0	100.0	100.0

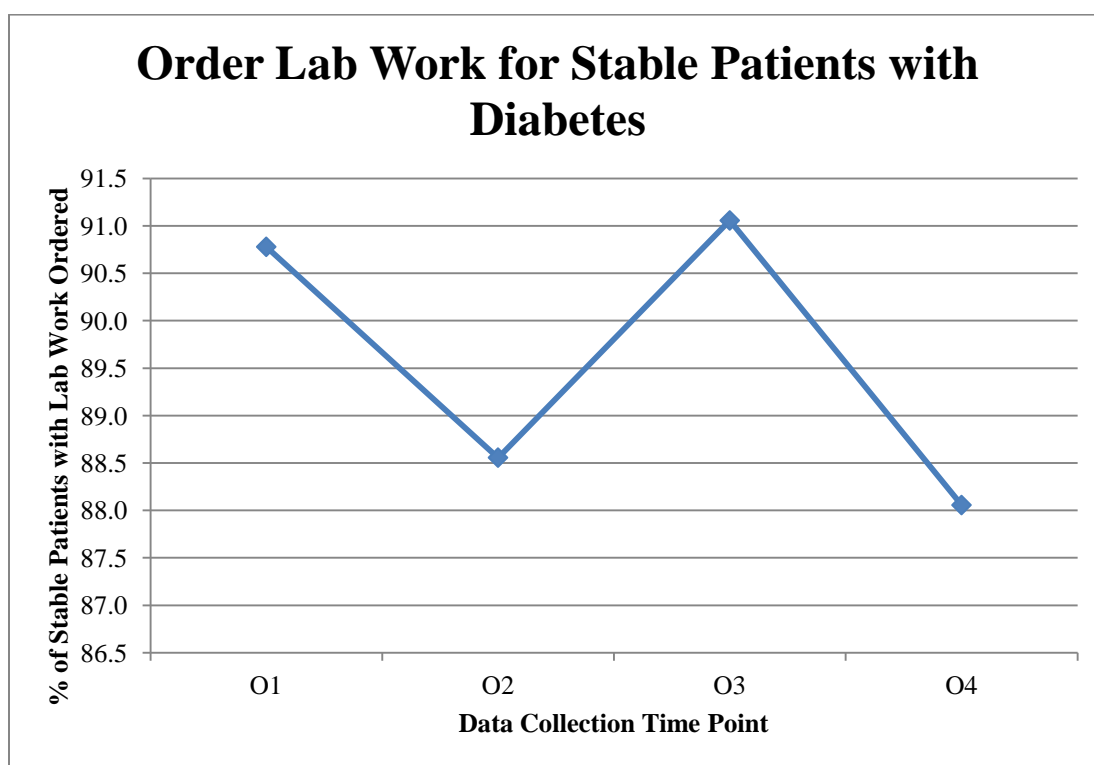


Figure 19 PCPs' Ordering of Lab Work for Stable Patients with Diabetes over Time

Table 20 PCPs' Ordering of Lab Work for Unstable Patients with Diabetes over Time

	Ordering Lab Work at O1	Ordering Lab Work at O2	Ordering Lab Work at O3	Ordering Lab Work at O4
<b>Mean</b>	92.44	94.61	95.33	90.56
<b>Median</b>	95.00	97.00	99.00	100.0
<b>Mode</b>	100.0	90.00 <sup>a</sup>	100.0	100.0
<b>Std. Deviation</b>	12.00	5.962	7.332	21.21
<b>Range</b>	50.00	20.00	25.00	80.00
<b>Minimum</b>	50.00	80.00	75.00	20.00
<b>Maximum</b>	100.0	100.0	100.0	100.0

<sup>a</sup> More than one mode exists, only the first is reported

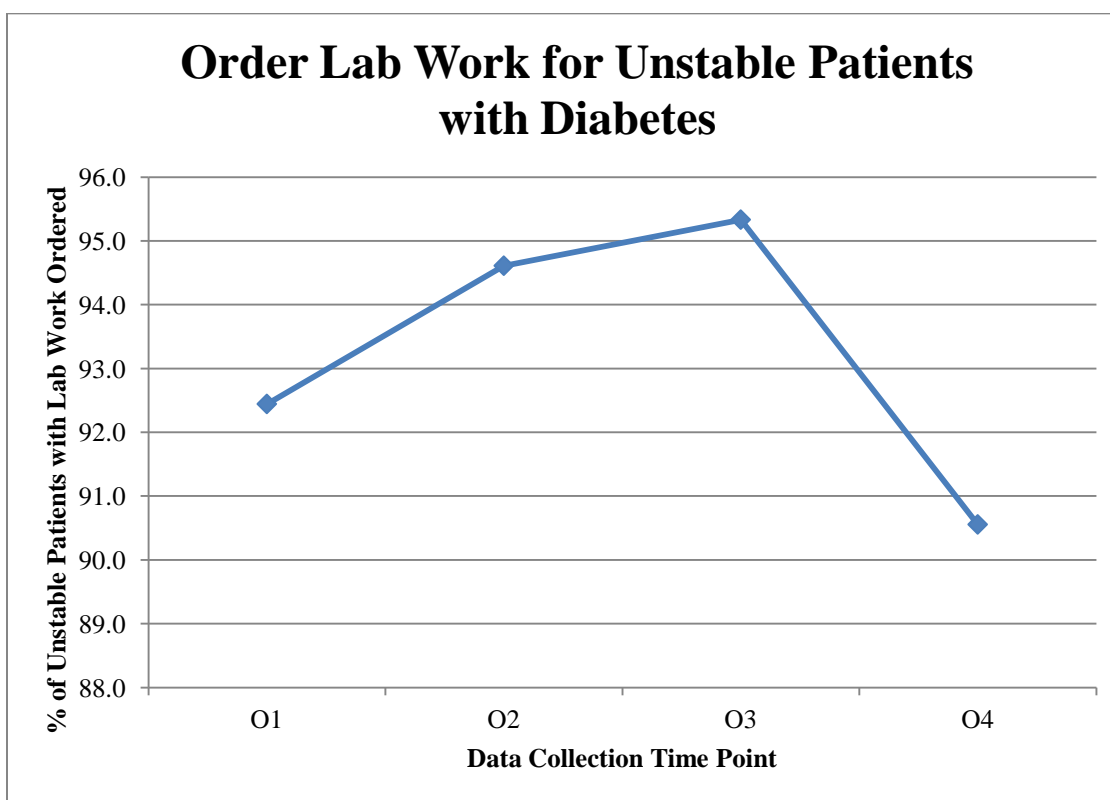


Figure 20 PCPs' Ordering of Lab Work for Unstable Patients with Diabetes over Time

Table 21 PCPs' Recording of Blood Pressure for Stable Patients with Diabetes over Time

	<b>Record Blood Pressure at O1</b>	<b>Record Blood Pressure at O2</b>	<b>Record Blood Pressure at O3</b>	<b>Record Blood Pressure at O4</b>
<b>Mean</b>	76.67	81.94	84.17	89.33
<b>Median</b>	85.00	90.00	90.00	92.50
<b>Mode</b>	95.00	90.00	90.00	100.0
<b>Std. Deviation</b>	24.07	17.75	17.59	12.96
<b>Range</b>	90.00	50.00	70.00	50.00
<b>Minimum</b>	10.00	50.00	30.00	50.00
<b>Maximum</b>	100.0	100.0	100.0	100.0

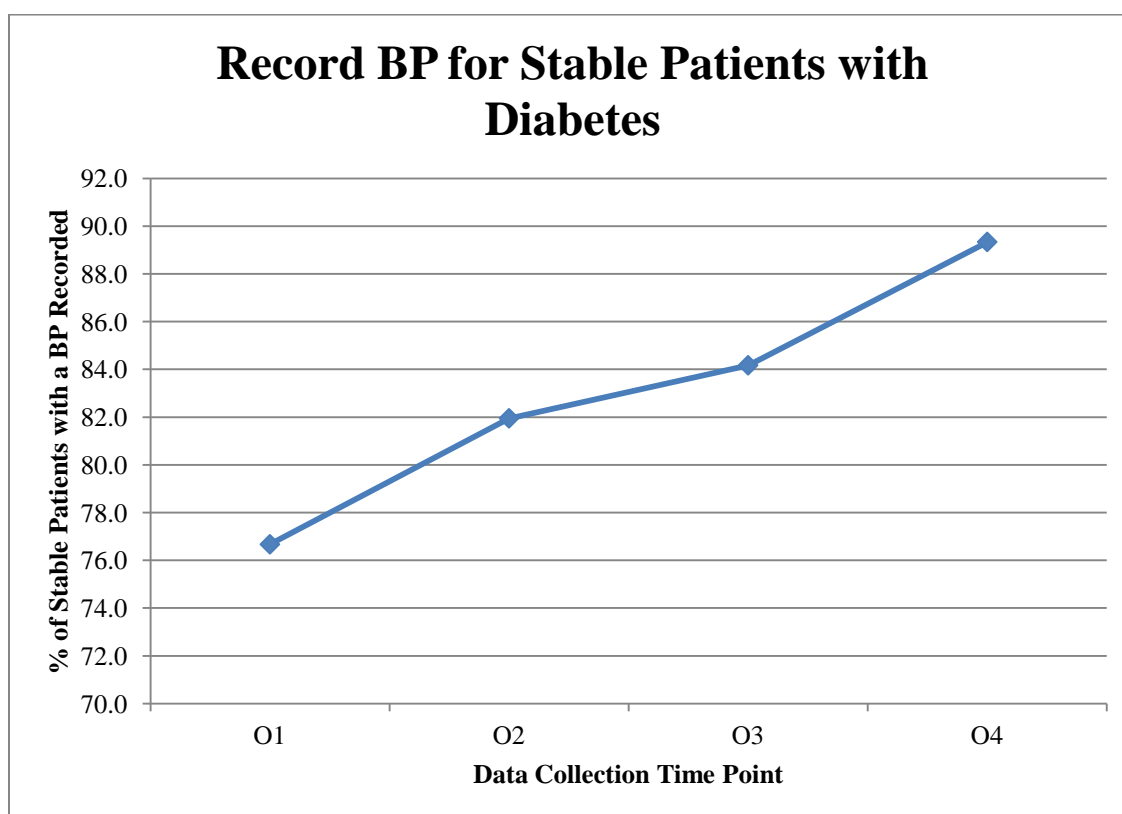


Figure 21 PCPs' Recording of Blood Pressure for Unstable Patients with Diabetes over Time

Table 22 PCPs' Recording of Blood Pressure for Unstable Patients with Diabetes over Time

	<b>Record Blood Pressure at O1</b>	<b>Record Blood Pressure at O2</b>	<b>Record Blood Pressure at O3</b>	<b>Record Blood Pressure at O4</b>
<b>Mean</b>	81.67	88.56	85.67	89.28
<b>Median</b>	90.00	90.00	92.50	90.00
<b>Mode</b>	90.00	90.00 <sup>a</sup>	100.0	100.0
<b>Std. Deviation</b>	23.45	15.47	18.76	10.67
<b>Range</b>	90.00	50.00	70.00	30.00
<b>Minimum</b>	10.00	50.00	30.00	70.00
<b>Maximum</b>	100.0	100.0	100.0	100.0

<sup>a</sup> More than one mode exists, only the first is reported

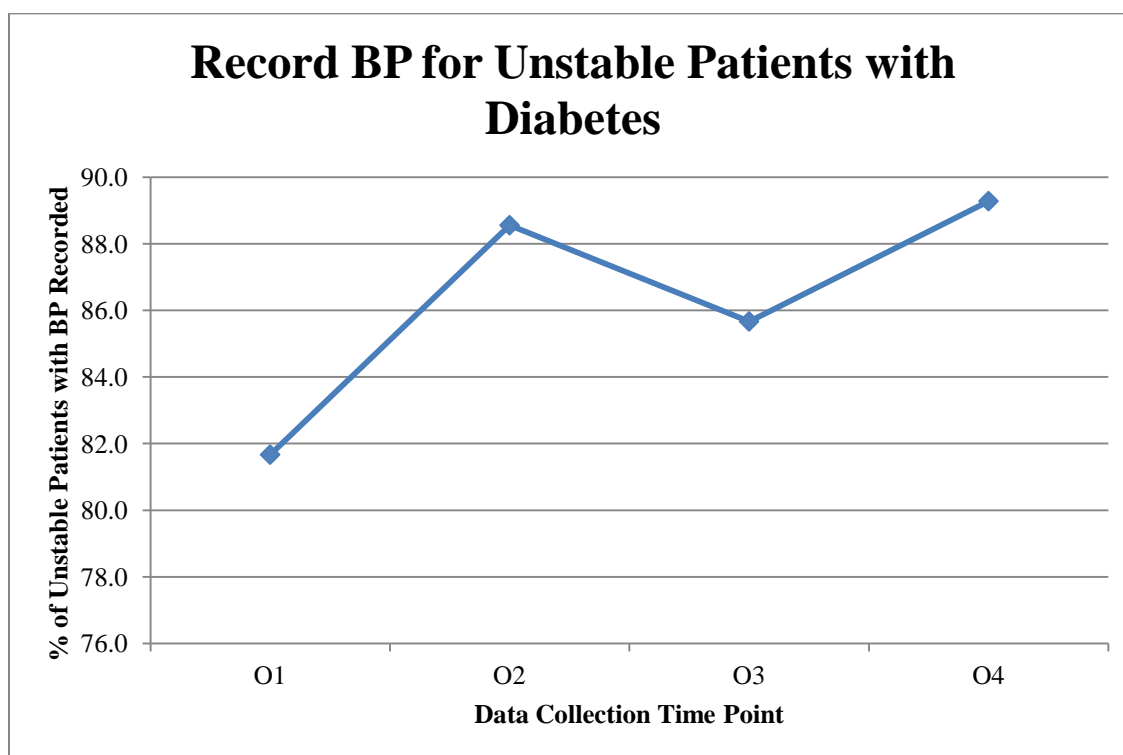


Figure 22 PCPs' Recording of Blood Pressure for Unstable Patients with Diabetes over Time

### 6.2.3 Relationships Between Physician Characteristics

The Kendall's tau-b rank correlation coefficients are shown in Table 23. The following PCP characteristics had a strong and positive association, which was statistically significant:

- Age and Years of practice,  $\tau_b = .658, p < .01$ .
- Years of experience using OSCAR EMR and Number of EMRs used,  $\tau_b = .591, p < .01$ .
- Computer skills and EMR skills,  $\tau_b = .702, p < .01$ .

The following PCP characteristics had a strong and negative association, which was statistically significant:

- Years of EMR experience and Years of experience using OSCAR EMR,  $\tau_b = -.661, p < .01$ .
- Years of practice and Number of EMRs used,  $\tau_b = -.578, p < .01$ .

**Table 23 Kendall's tau-b Correlations Between PCP Characteristics**

Variable	1	2	3	4	5	6
1 Age	1					
2 Years of Practice	.658**	1				
3 Years of EMR Experience	.099	.179	1			
4 Years of Experience using OSCAR EMR	-.252	-.244	-.661**	1		
5 Number of EMRs Used	-.364	-.578**	-.240	.591**	1	
6 Computer Skills	-.119	.045	.168	.000	.058	1
7 EMR Skills	.110	.150	.279	-.198	-.150	.702**

\*\* Correlation is significant at the .01 level (2-tailed).

There were weak, positive associations between the following PCP characteristics, which were not statistically significant:

- Age and years of EMR experience,  $\tau_b = .099, p = .65$ .
- Years of practice and years of EMR experience,  $\tau_b = .179, p = .42$ .
- Years of practice and computer skills,  $\tau_b = .045, p = .84$ .
- Computer skills and years of EMR experience,  $\tau_b = .168, p = .45$ .
- Computer skills and number of EMRs used,  $\tau_b = .058, p = .79$ .
- EMR skills and age,  $\tau_b = .110, p = .62$ .
- EMR skills and years of practice,  $\tau_b = .150, p = .51$ .
- EMR skills and years of EMR experience,  $\tau_b = .279, p = .22$ .

There were weak, negative associations between the following PCP characteristics, which were not statistically significant:

- Age and years of experience using OSCAR EMR,  $\tau_b = -.252, p = .24$ .
- Years of experience using OSCAR EMR and years of practice.  $\tau_b = -.244, p = .26$ .
- Number of EMRs used and years of EMR experience,  $\tau_b = -.240, p = .27$ .
- Age and computer skills,  $\tau_b = -.119, p = .58$ .
- EMR skills and years of experience using OSCAR EMR,  $\tau_b = -.198, p = .38$ .
- EMR skills and number of EMRs used,  $\tau_b = -.150, p = .50$ .

#### **6.2.4 Relationships Between Physician Characteristics and EMR Use for Diabetes**

Table 24 shows the respective Kendall's tau-b and Pearson's correlation coefficients for PCP characteristics and the baseline MCEU scores at O1. Number of EMRs used was strongly and negatively correlated,  $r(16) = -.548, p < .05$ . The following PCP characteristics were moderately and positively correlated with the MCEU score for diabetes care at O1:

- Age,  $\tau_b = .426, p < .05$ .

- Years of practice,  $\tau_b = .456, p < .05$ .

**Table 24 Correlations of Physician Characteristics with O1 Score**

Physician Characteristic	Correlation Coefficient	Significance
Age	.426*	.030
Years of Practice	.456*	.022
Years of EMR Experience	.153	.445
Years of Experience using OSCAR EMR	-.217	.271
Number of EMRs Used	-.548* <sup>p</sup>	.018
Computer Skills	.119	.549
EMR Skills	.360	.077

\* Correlation is significant at the 0.05 level (2-tailed).

<sup>p</sup> Pearson's Correlation Coefficient; all other correlations are Kendall's tau-b

For categorical variables (sex, health authority, and prior post-implementation EMR training), the group statistics and t-test results for differences in use of EMR features for diabetes care at O1 are outlined in Tables 25 and 26 below. There were no significant correlations.

**Table 25 Differences in the Dependent Variable between Groups of Categorical Variables (Physician Characteristics)**

Variable	Group	N	M	S.D.	Std. Error Mean	t(df=16)	Sig.	Effect Size (dz)	Post-Hoc Power (1- $\beta$ error prob)
Sex	Male	6	72.83	14.13	5.77	.86	.40	0.43	.21
	Female	12	66.75	14.17	4.09				
Health Authority	Vancouver Island	12	71.08	11.70	3.38	.98	.34	0.49	.24
	Fraser Valley & Van. Coastal	6	64.17	18.21	7.44				
Prior Post-Implementation EMR Training	Yes	9	73.00	10.70	3.57	1.30	.21	0.65	.37
	No	9	64.56	16.27	5.42				

### 6.2.5 Effects of Physician Characteristics on EMR Use for Diabetes Care at O1

A multiple regression was run to predict EMR use for diabetes care from three variables: years of practice, EMR skills, and prior post-implementation training. Years of practice and EMR skills were selected because they were correlated with age and computer skills, respectively. Prior post-implementation training was selected because of its large effect size (0.65). The multiple regression model statistically significantly predicted EMR use for diabetes care,  $F(3, 14) = 3.80$ ,  $p = .04$ ,  $R^2 = .45$ . Only one variable (years of practice) added statistically significantly to the prediction,  $p = .05$ . Regression coefficients and standard errors are presented in Table 28 (below).

**Table 28 Summary of Multiple Linear Regression**

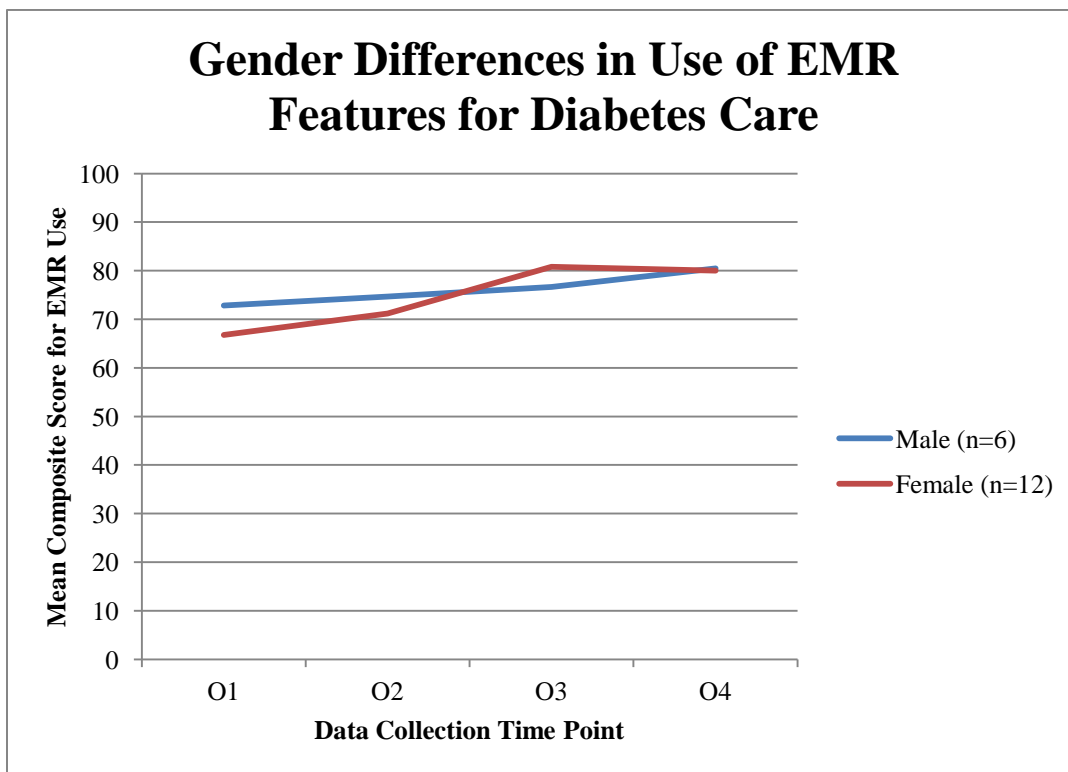
Variable	Unstandardized	Standard Error	Standardized	t	p
<b>(Intercept)</b>	44.132	15.532		2.841	0.01
<b>Years of Practice</b>	4.440	2.092	0.483	2.122	0.05
<b>EMR Skills</b>	5.913	5.570	0.231	1.062	0.31
<b>Prior PostImplementation EMR Training</b>	-4.498	5.729	-0.165	-0.785	0.45

### 6.2.6 Effects of Physician Characteristics on EMR Use for Diabetes Care

The effects of physician characteristics on EMR Use for diabetes care over time are graphically illustrated in Figures 23-34. In general, graphical trends indicate that PCPs with the following characteristics had higher increases in MCEU score for diabetes care from O1 to O4: (1) being female, (2) being aged 35-44, (3) being from Vancouver Island, (4), having less than 4 years of medical practice, (5) having 3-4 years of EMR experience, (6) having 1-2 years of OSCAR EMR experience, (7) using four EMRs, and

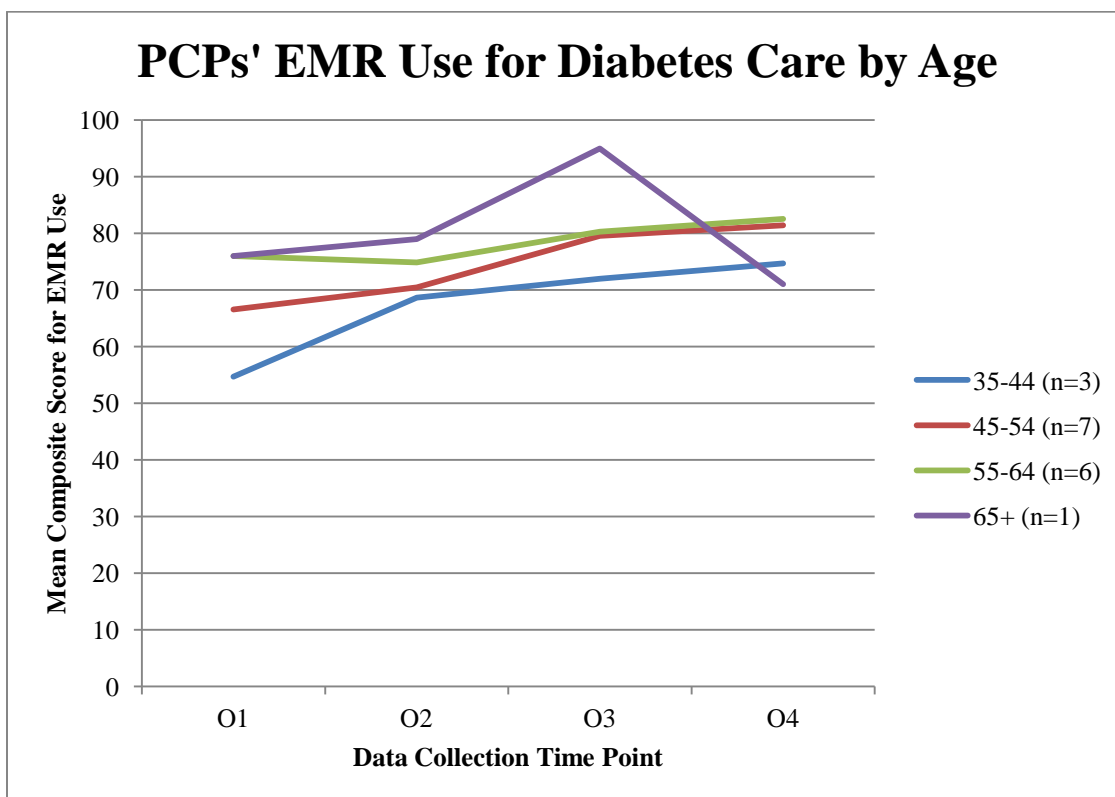
(8) having prior post-implementation EMR training. Details of the effects of physician characteristics on MCEU score are described in detail below.

Figure 24 shows the MCEU score for diabetes care over time by **gender**. Female PCPs had a slightly lower MCEU score at O1 and showed a greater increase in MCEU score between O1 and O4 (i.e., 13.25 percentage point increase for female PCPs from 66.75% to 80%, as compared to 7.67 point increase for males from 72.83% to 80.5%), especially between O2 and O3 (9.66 percentage point increase for females vs. 2 percentage point increase for males). Both male and female PCPs had a similar MCEU score for diabetes care at O4 (i.e., 80.5% for males and 80% for females).



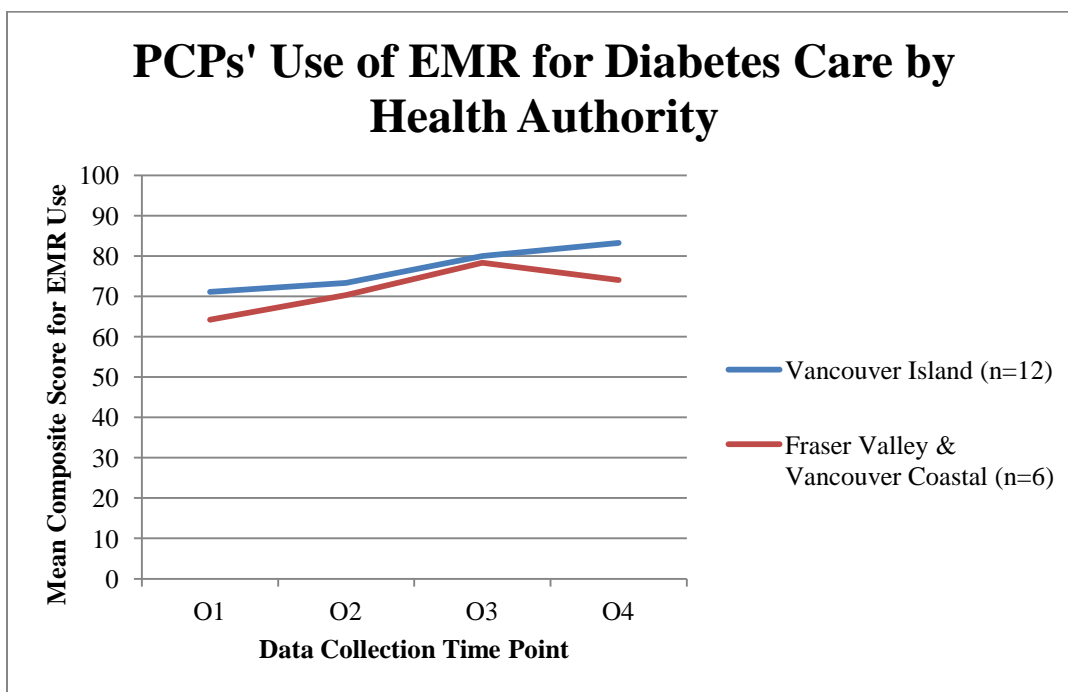
**Figure 23**

There was considerable variation in PCPs' EMR use for diabetes care by **age group** (Figure 24). In general, the MCEU scores for diabetes care increased for all age groups over time, except for one PCP who was aged 65+. At O1, PCPs aged 55+ had the highest MCEU score (76%), while PCPs aged 35-44 had the lowest score (54.67%). Between O1 and O4, the 35-44 age group experienced the highest increase in MCEU score (i.e., 20 percentage point increase from 54.67% to 74.67%), followed by PCPs aged 45-54 (i.e., 14.89 percentage point increase from 66.57% to 81.43%). Although the MCEU score for the PCP aged 65+ (n=1) had increased from O1 to O3, his MCEU score declined at O4 (five percentage point decrease between O1 and O4, from 76% to 71%), making it the lowest MCEU score by age group. While PCPs aged 45-54 had a slightly lower MCEU score at O1 than PCPs aged 55-64, both age groups had a similar MCEU score at O4.



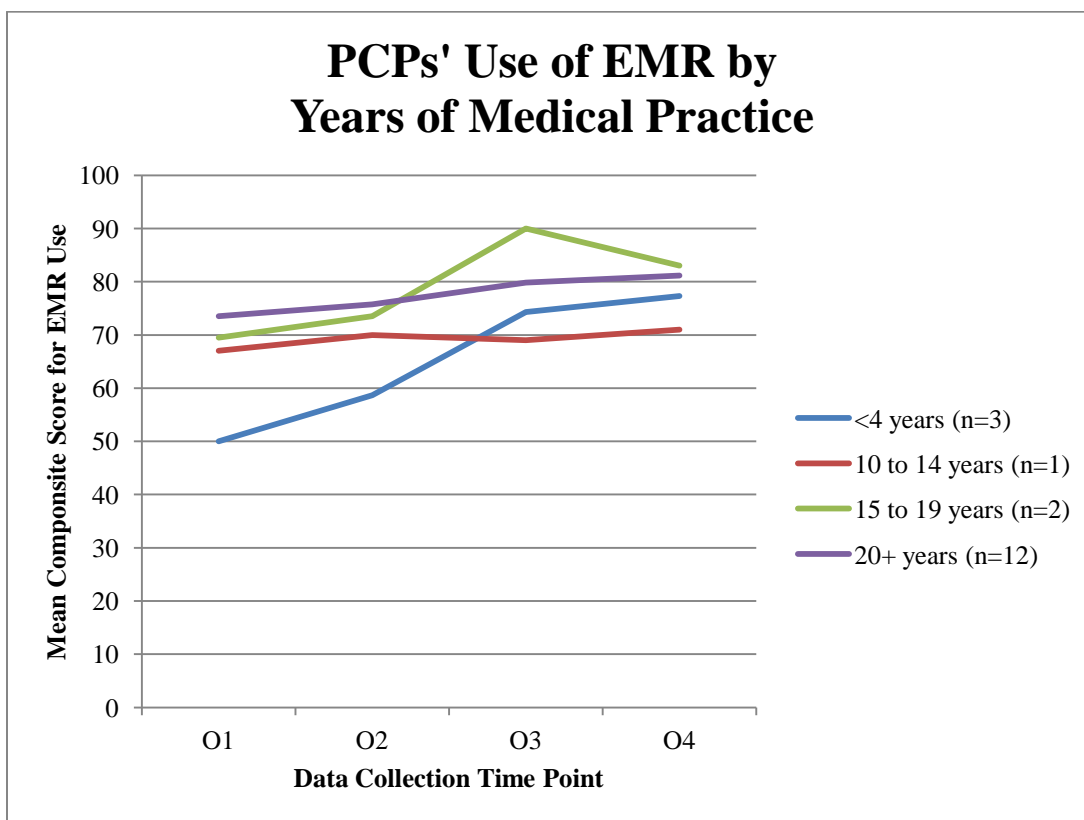
**Figure 24**

In terms of **health authority**, PCPs from Vancouver Island and the Fraser Valley and Vancouver Coastal health authorities (combined) showed an increase in MCEU score for diabetes care (Figure 25). However, PCPs from Fraser Valley and Vancouver Coastal consistently had a lower MCEU score at all data collection time points (O1-O4), as compared to PCPs from Vancouver Island. PCPs from Vancouver Island also had a slightly higher MCEU score for diabetes care between O1 and O4 than those from Fraser Valley and Vancouver Coastal (i.e., 12.17 percentage point increase in MCEU score for Vancouver Island vs. 9.83 percentage point increase for Fraser Valley and Vancouver Coastal).



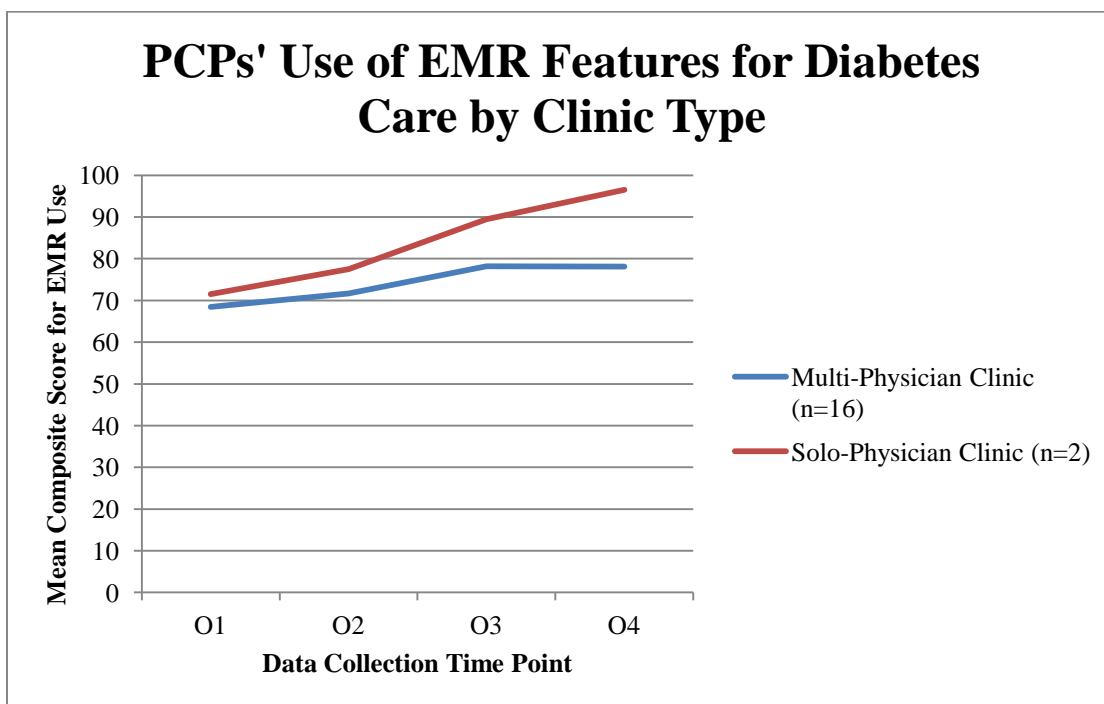
**Figure 25**

For **years of medical practice** (Figure 26), the MCEU scores increased from O1 to O4 for PCPs across all four groups (i.e., <4 years to 20+ years). Similar to PCP age, PCPs with less than four years of medical practice had the lowest MCEU score at O1 (50%), while PCPs with 20+ years experience had the highest score (73.5%). However, PCPs with less than four years' experience had the highest increase in MCEU score from O1 to O4 (i.e., 27.33 percentage points, from 50% to 77.33%), followed by PCPs with 14-19 years of medical practice (i.e., 13.5 percentage points, from 69.5% to 83%). At O4, PCPs with 14-19 years of medical practice had the highest MCEU score (83%), while PCPs with 10-14 years had the lowest score (71%).



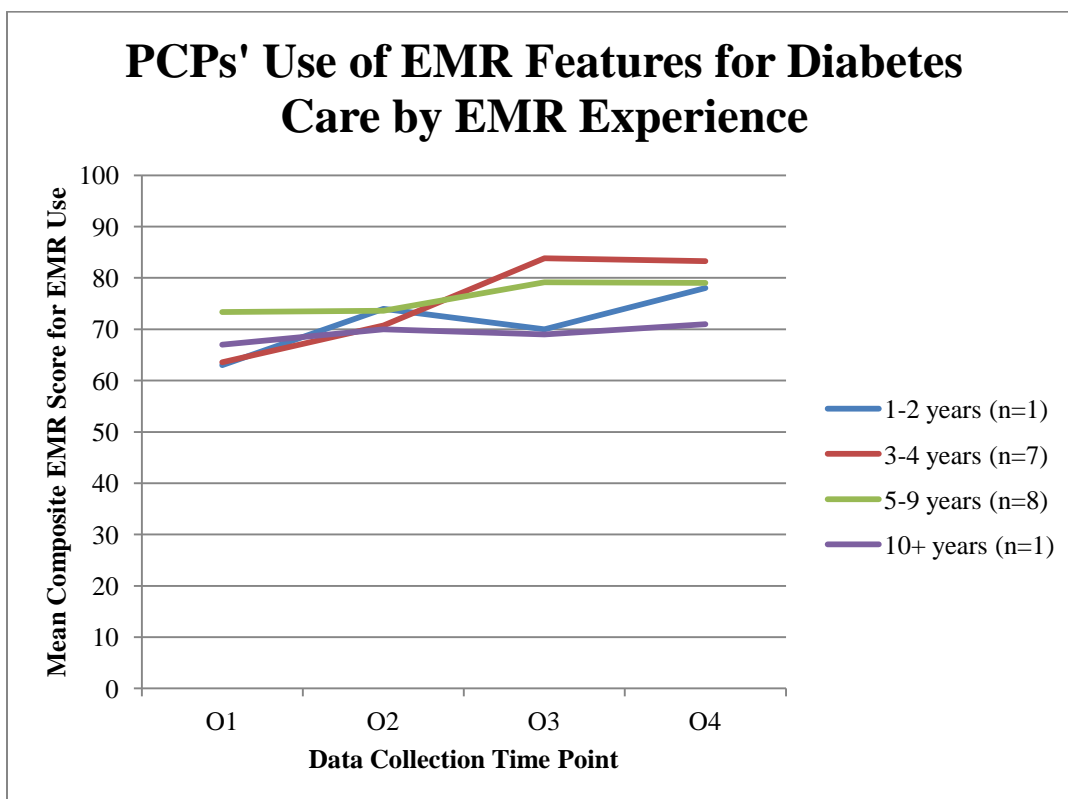
**Figure 26**

In terms of PCPs' **clinic type** (Figure 27), The MCEU use score increased for both solo-physician and multi-physician practice PCPs from O1-O4. The two solo-physician practice PCPs had a consistently higher MCEU score was across data collection time points O1-O4, and showed greater increase in MCEU score from O1 to O4, than multi-physician practice PCPs (i.e., 25 percentage points increase vs. 9.69 percentage points increase, respectively).



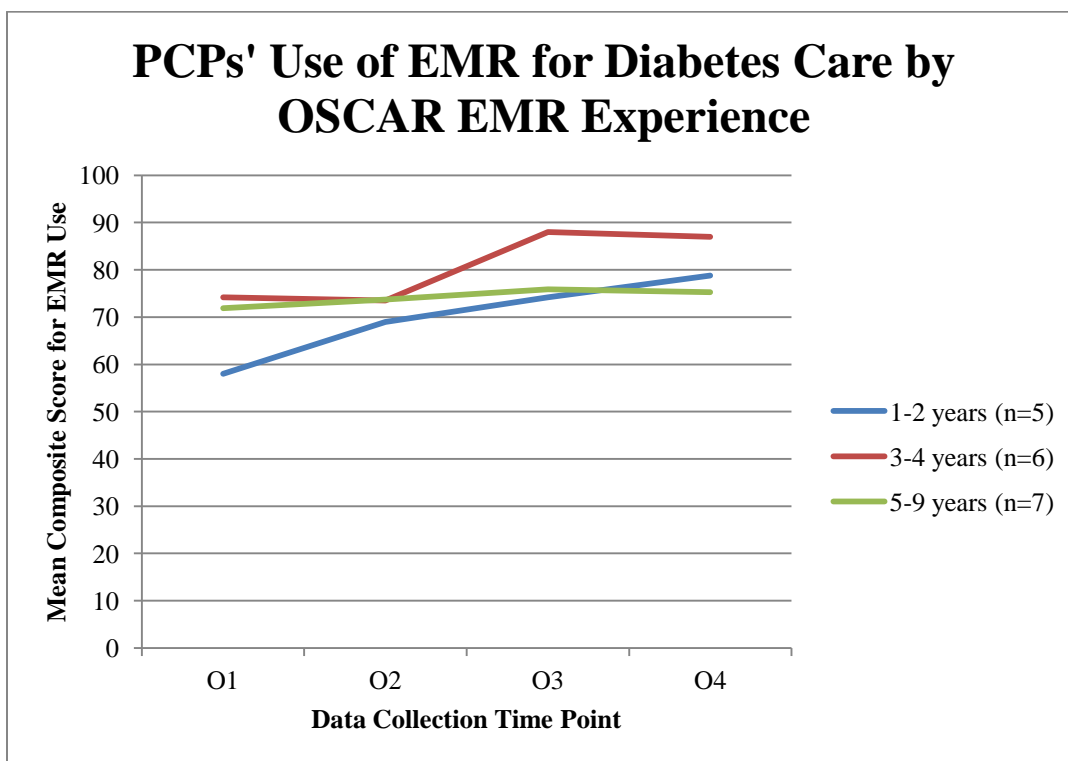
**Figure 27**

In comparing PCPs by **EMR experience** (Figure 28), the MCEU score increased for PCPs in all four groups of EMR experience from O1 to O4. PCPs with 3-4 years of EMR experience had the greatest MCEU score increase from O1 to O4 (19.72 percentage points, from 63.57% to 83.29%, respectively), whereas PCPs with 10+ years of experience had the lowest increase (4 percentage points, from 67% to 71%). In general, PCPs with 1-4 years of EMR experience had a higher increase in MCEU score for diabetes care (i.e., 15 percentage points, from 63% to 78%) than PCPs with 5-9 years (5.63 percentage points, from 73.38 to 79) or 10+ years of EMR experience (4 percentage point increase, from 67% to 71%).



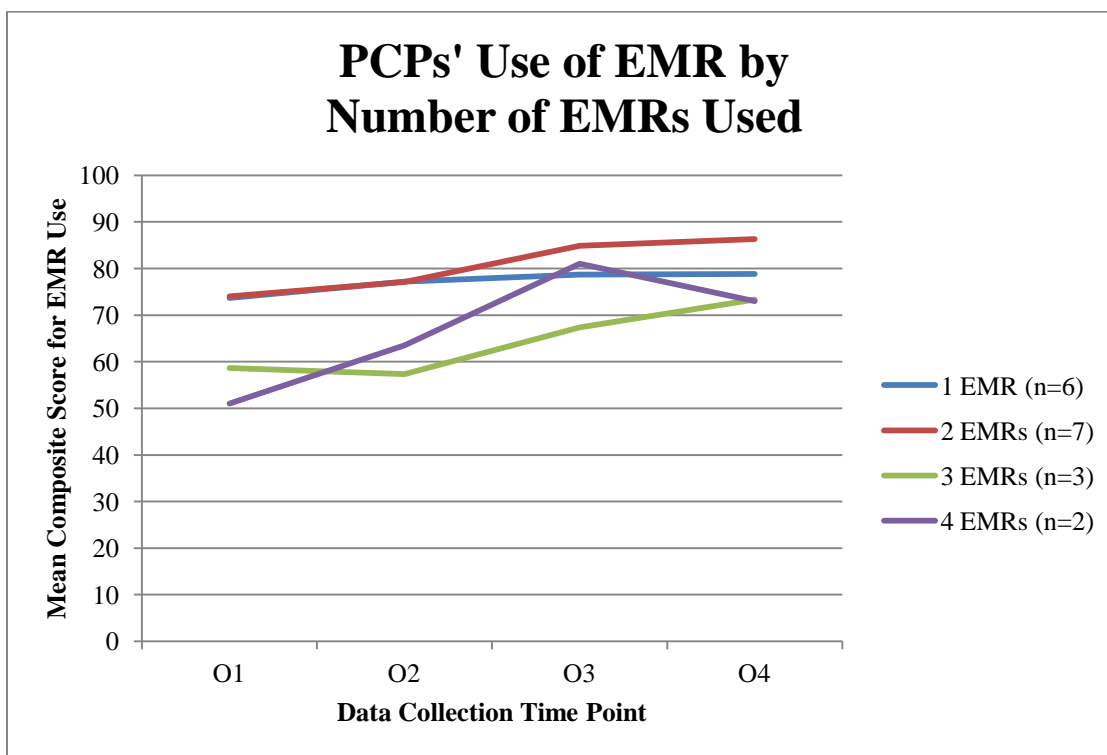
**Figure 28**

The MCEU score for diabetes care increased from O1 to O4 for PCPs with various years of **OSCAR EMR experience** (Figure 29). At O1, PCPs with 3-4 years of OSCAR EMR experience had the highest MCEU score, while PCPs with 1-2 years of OSCAR EMR experience had the lowest score. However, PCPs with 1-2 years of OSCAR EMR experience had the highest increase in MCEU score from O1 to O4 (i.e., 20.8 percentage points, from 58% to 78.8%), followed by PCPs with 3-4 years of OSCAR EMR experience (i.e., 12.83 percentage points, from 74.17% to 87%). PCPs with 5-9 years of OSCAR EMR had the lowest increase in MCEU score from O1 to O4 (i.e., 3.43 percentage points, from 71.86% to 75.29%).



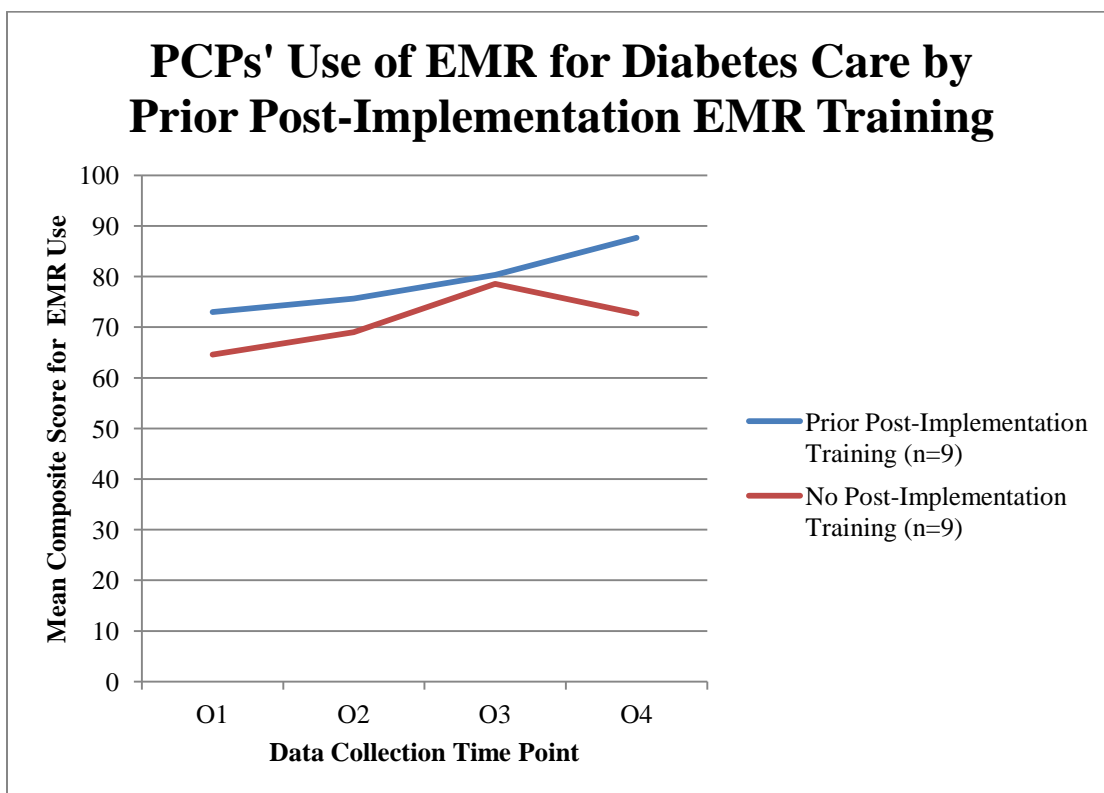
**Figure 29**

In terms of **number of EMRs used**, the MCEU score increased from O1 to O4 for PCPs who had used 1-4 EMRs (Figure 30). The two PCPs who used four EMRs experienced the highest increase in MCEU score from O1 to O4 (i.e., 22 percentage points, from 51% to 73%), followed by PCPs who used three EMRs (i.e., 14.66 percentage points, from 58.67% to 73.33%) and two EMRs (i.e., 12.29 percentage points, from 74% to 86.29%). PCPs who used one EMR experienced the lowest increase in MCEU score from O1 to O4 (i.e., 5.16 percentage points, from 73.67% to 78.83%). At O4, PCPs who used two EMRs had the highest MCEU score, while PCPs who used three or four EMRs had the lowest score.



**Figure 30**

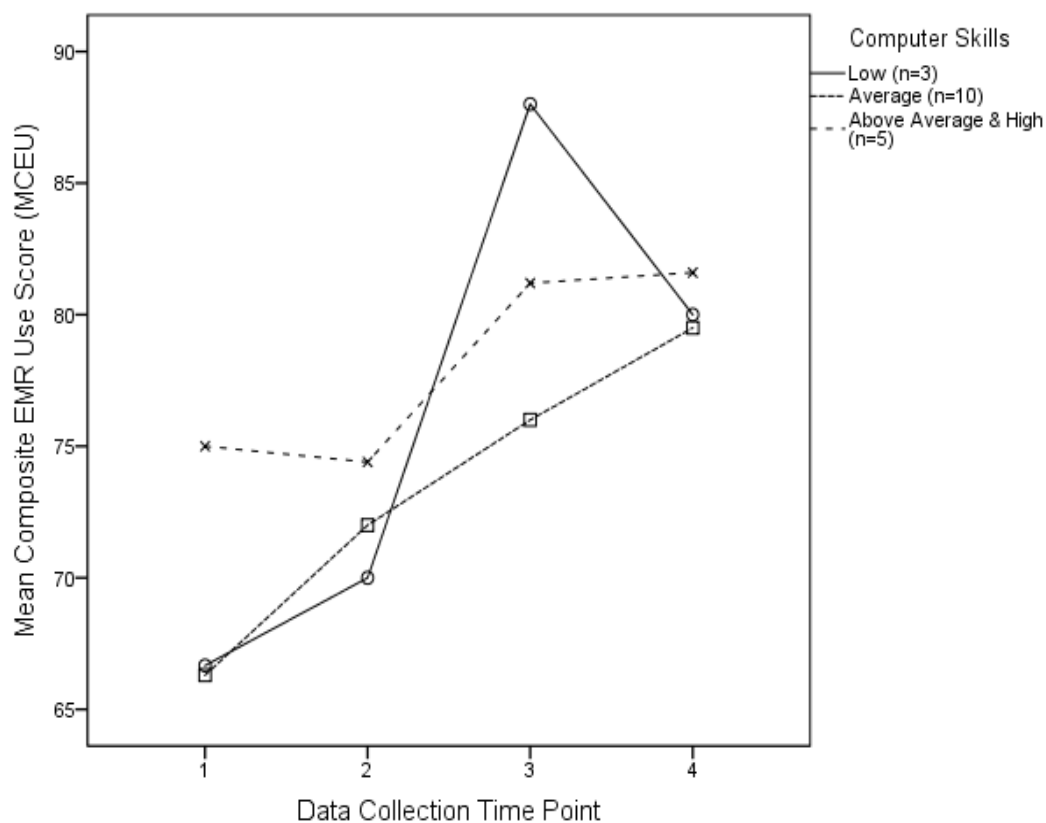
The MCEU score for diabetes care increased from O1 to O4 for both PCPs who *did* and *did not* have **prior post-implementation EMR training** (Figure 31). However, MCEU scores were consistently lower from O1-O4 for PCPs who *did not* have prior post-implementation EMR training, as compared to those who *did*. PCPs *without* prior-post implementation EMR training experienced a higher increase in MCEU score between O1 and O3 (14 percentage points, from 64.56% to 78.56%), but their MCEU score slightly decreased (5.89 percentage points, from 78.56% to 72.67%) from O3 to O4. As a result, PCPs *with* prior-post implementation EMR training had a higher increase in MCEU score from O1 to O4 (14.67 percentage points from 73% to 87.67% vs. 8.11 percentage points from 64.56% to 72.67% for PCPs without post-implementation EMR training).



**Figure 31**

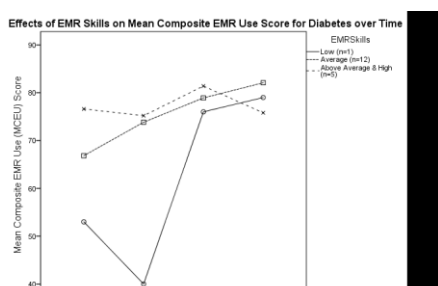
The MCEU score for diabetes care increased from O1 to O4 for PCPs with all levels of **computer skills** (Figure 32). However, the one PCP with low computer skills had the highest increase in MCEU score from O1 to O4 (13.33 percentage points, from 66.67% to 80%), followed by average computer skills (13.20 percentage points, from 66.3% to 79.5%). PCPs with above average or high EMR skills had a 7.16 percentage point increase in MCEU score from O1 to O4, from 70.67% to 77.83%.

**Effects of Computer Skills on Mean Composite EMR Use Score for Diabetes over Time**



**Figure 32 PCPs' EMR Use for Diabetes Care by Computer Skills**

In comparing **EMR skills** (Figure 33), the MCEU score for diabetes care increased from O1 to O4 for PCPs with low and average EMR skills, whereas it slightly decreased for PCPs with above average and high EMR skills. From O1 to O4, the PCP (n=1) with low EMR skills had the highest increase in MCEU score (26 percentage points, from 53% to 79%). The majority of PCPs with average EMR skills (n=12/18) had a 15.25 percentage point increase in MCEU score from O1 to O4 (from 66.83% to 82.08%).



**Figure 33 PCPs' EMR Use for Diabetes Care by EMR Skills**

To test if any of the above trends represent significant interaction effects of physician characteristics and time of measurement, a series of two-way mixed ANOVAs with repeated measures was conducted. In each two-way mixed ANOVA, each physician characteristic was included as a between-subjects factor, time of measurement was entered as the within-subjects factor, and MCEU was the dependent variable. The results of the two-way mixed ANOVAs are summarized in Table 29 below. All mixed ANOVAs confirmed the significant main effect of time, similar to the rANOVA described in section 6.2.7 below: no significant main effects of physician characteristics were found, and the only significant interaction effect was of time x EMR skills (see also Figure 34). Specifically, there was a statistically significant difference in MCEU between EMR skills

at O2,  $F(2, 15) = 8.042$ ,  $p = .004$ , partial  $\eta^2 = .517$ . Due to insufficient data (i.e. small cells), simple main effects could not be examined.

**Table 29 Summary of Two-Way Mixed ANOVA's for PCP Characteristics, Time, and MCEU**

PCP characteristic	Main effect of Time			Interaction Effect (time x physician characteristic)		
	F(df)	Sig.	partial $\eta^2$	F(df)	Sig.	partial $\eta^2$
Age	$F(3, 42) = 3.765$	$p = .018$	.212	$F(9, 42) = .834$	$p = .589$	.152
Gender	$F(3, 48) = 4.739$	$p = .006$	.228	$F(3, 48) = .951$	$p = .423$	.056
Health authority	$F(3, 42) = 3.765$	$p = .018$	.212	$F(3, 48) = .588$	$p = .626$	.035
Years of practice	$F(3, 42) = 4.605$	$p = .007$	.248	$F(9, 42) = 1.175$	$p = .335$	.201
Type of practice	$F(3, 48) = 5.648$	$p = .002$	.261	$F(3, 48) = 1.00$	$p = .401$	.059
Years of EMR experience	$F(3, 42) = 1.988$	$p = .130$	.124	$F(9, 42) = 1.057$	$p = .414$	.185
Years of OSCAR EMR experience	$F(3, 45) = 8.176$	$p < .001$	.353	$F(6, 45) = 1.616$	$p = .165$	.177
Number of EMRs used	$F(3, 42) = 7.906$	$p < .001$	.361	$F(9, 42) = .949$	$p = .494$	.169
Prior post-implementation training	$F(3, 48) = 7.099$	$p < .001$	.307	$F(3, 48) = 1.728$	$p = .174$	.097
Computer skills	$F(3, 45) = 6.314$	$p = .001$	.296	$F(6, 45) = 0.756$	$p = .608$	.092
EMR Skills	$F(3, 45) = 7.514$	$p < .001$	.334	$F(6, 45) = 2.731$	$p = .024$	.267

### 6.2.7 Effects of the Intervention on EMR Use for Diabetes Care

In a repeated-measures ANOVA (rANOVA), there were statistically significant changes in use of diabetes-related EMR features over time,  $F(3, 51) = 6.808$ ,  $p < .001$ , partial  $\eta^2 = .286$ . These results are summarized in Table 26, and illustrated in Figure 34. Given that partial eta-squared ( $\eta^2$ ) is .286 (i.e.,  $\eta^2 > 0.14$ ), the effect size is large (Clark,

n.d.; Cohen, 1988). Post hoc tests using the Bonferroni correction (see Table 27) revealed that there was an increase in MCEU score from O1 ( $M = 68.78$ ,  $SD = 14.05$ ) to O3 ( $M = 79.44$ ,  $SD = 11.65$ ), a statistically significant mean increase of 10.67, 95% CI [19.69, 1.65],  $p < .05$ . There was also an increase in MCEU score from O1 ( $M = 68.78$ ,  $SD = 14.05$ ) to O4 ( $M = 80.17$ ,  $SD = 14.39$ ), a statistically significant mean increase of 11.39, 95% CI [24.09, 1.37],  $p < .05$ . However, there were no statistically significant differences between O2 and O3 or between O2 and O4 ( $p = .111$  and  $p = .225$ , respectively). The increase in the mean scores from O2 to O3 and from O2 to O4 had a medium effect size (Cohen's  $d = 0.61$  and Cohen's  $d = 0.53$ , respectively).

**Table 26** rANOVA Results (Within Subjects Effects)

	Sum of Squares	df	Mean Square	F	p	$\eta^2$
Use of EMR Features over Time	1659	3	552.87	6.808	< .001	0.286
Residual	4142	51	81.21			

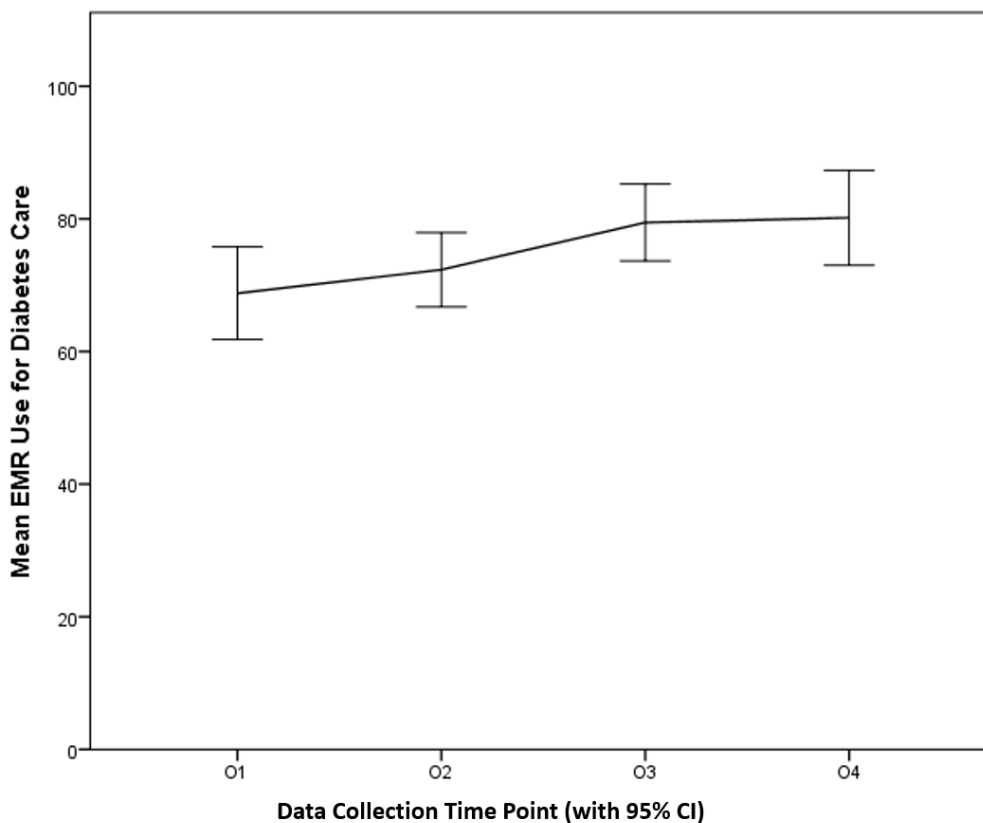
*Note.* Type III Sum of Squares

**Table 27** Post Hoc Tests for rANOVA

	Mean Difference*	SE	t	Cohen's d	$p_{\text{bonf}}$
O1 O2	3.556	2.535	1.403	0.331	1.000
O1 O3	10.667	3.023	3.529	0.832	0.015
O1 O4	11.389	3.358	3.392	0.799	0.021
O2 O3	7.111	2.731	2.604	0.614	0.111
O2 O4	7.833	3.470	2.257	0.532	0.225
O3 O4	0.722	2.793	0.259	0.061	1.000

*Note.* Cohen's  $d$  does not correct for multiple comparisons.

\* Mean differences between later and earlier measurement times



**Figure 34 EMR Use for Diabetes Care across Data Collection Time Points with 95% CI**

Given the possibility for confusion or variation in PCPs' understanding of appropriate monitoring intervals for ordering diabetes lab work, the MCEU at all four time points was also examined without the metrics for ordering lab work for stable and unstable patients with diabetes. Another rANOVA was conducted with the new MCEU scores (i.e., without lab ordering metrics). According to the second rANOVA, the MD-PET intervention elicited statistically significant changes in use of diabetes-related EMR features (excluding ordering lab work) over time,  $F(3, 51) = 9.276, p < .001$ , partial  $\eta^2 = .353$ . The exclusion of the EMR features related to the diabetes lab ordering feature revealed a larger effect size as compared to including the lab ordering features (i.e.,  $\eta^2 = .353$  vs.  $\eta^2 = .286$ , respectively). Post hoc tests using the Bonferroni correction for this

second rANOVA revealed that there was an increase in MCEU score from O1 ( $M = 62.23$ ,  $SD = 15.50$ ) to O3 ( $M = 75.59$ ,  $SD = 13.72$ ), a statistically significant mean increase of 13.36, 95% CI [-23.86, -2.87],  $p < .01$ . There was also an increase in EMR use from O1 ( $M = 62.23$ ,  $SD = 15.50$ ) to O4 ( $M = 77.54$ ,  $SD = 3.36$ ), a statistically significant mean increase of 15.29, 95% CI [-26.59, -4.43],  $p < .01$ . However, as in the initial rANOVA, there were no statistically significant differences between O2 and O3 or between O2 and O4 ( $p = .119$  and  $p = .061$ , respectively). There was a medium effect size between O2 and O3 (Cohen's  $d = 0.61$ ) and also between O2 and O4 (Cohen's  $d = 0.68$ ).

### 6.3 Qualitative Results

The thematic analysis of 21 interviews (12 interviews at O3 and nine interviews at O4) and data from the Diabetes Care (DC) questionnaires revealed nine themes (Figure 35), which fall into two main categories: (1) Design and development of EMR video tutorials and (2) Adoption and use of EMR video tutorials. A summary table of the themes can also be seen in Table 30.

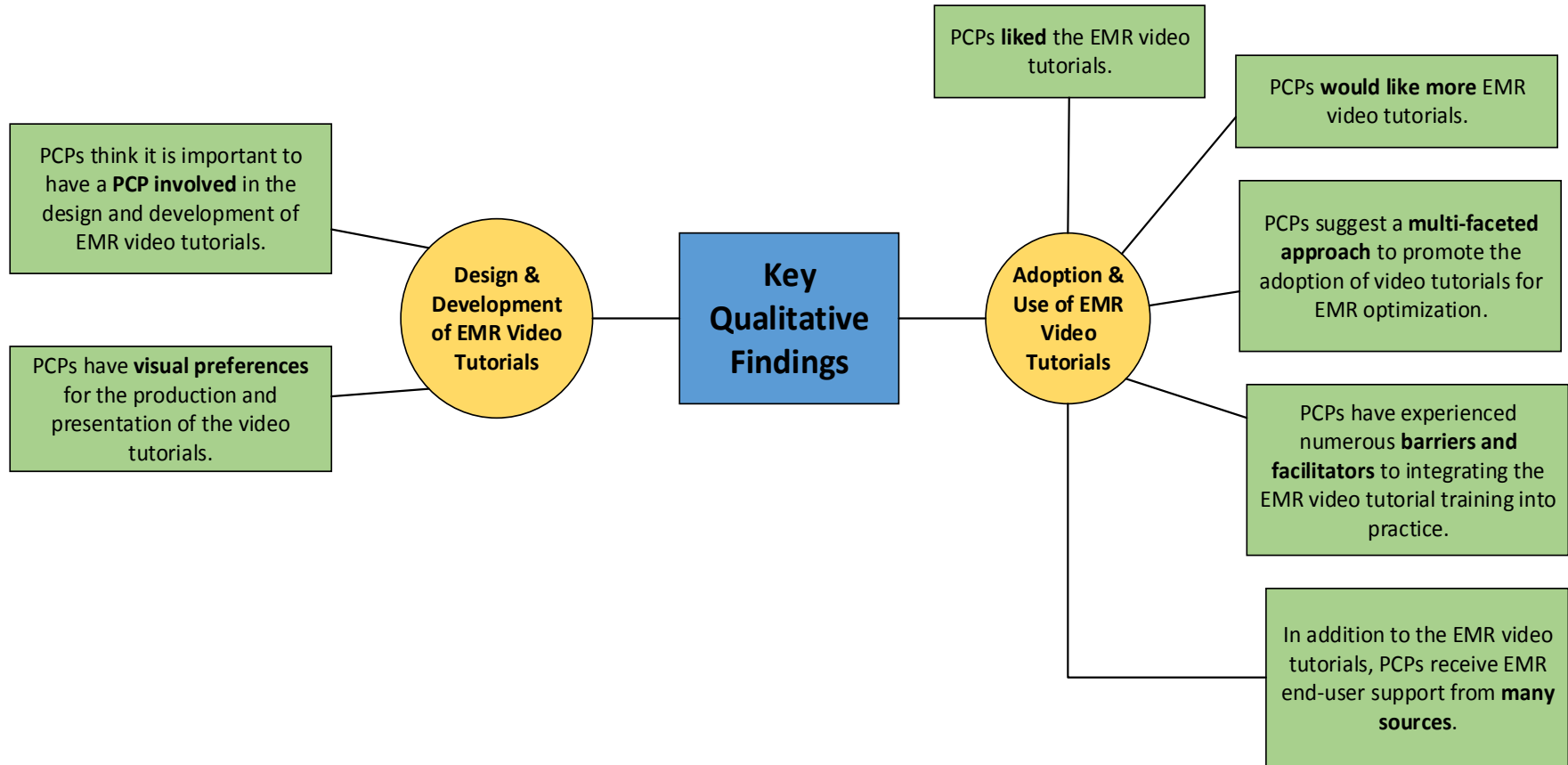


Figure 35 Thematic Analysis Themes

Table 30 Summary of Thematic Analysis Themes

Theme	Main Findings
<b>PCPs liked the EMR video tutorials.</b>	PCPs had a positive reaction to the video tutorials.
	PCPs liked the EMR video tutorial trainer. They found him to be a clear and knowledgeable expert who is good spokesperson for PCPs.
	PCPs did not feel anything was missing from the EMR video tutorials for diabetes care management.
	PCPs would recommend other PCPs to watch the EMR video tutorials.
<b>PCPs would like more EMR video tutorials.</b>	PCPs would like short, online EMR video tutorials on a breadth and depth of topics to support PCPS at different EMR use levels and in different communities.
	PCPs would like a searchable library of EMR video tutorials. It would be helpful for the video tutorials to be embedded in the EMR to increase accessibility at the point of care.
	PCPs think it may be helpful to develop EMR video tutorials for MOAs.
<b>PCPs think it is important to have a PCP involved in the design and development of EMR video tutorials.</b>	PCPs prefer to have a practicing PCP involved in the design of EMR video tutorials to develop short and simple learning content that is appropriate for the audience.
	PCPs would prefer a well-spoken, professional, engaging, and credible physician trainer who is an experienced EMR user that they can trust and relate to. Including the biography of the trainer with the EMR video tutorials may be helpful.
<b>PCPs have visual preferences for the production and presentation of the video tutorials.</b>	PCPs would like to continue seeing the on-screen EMR navigation in the video tutorials.
	PCPs would find it valuable to see the trainer in the EMR video tutorials (i.e., see video of trainer's face and not just their audio/voice) to increase the audience's connection with the trainer.
	PCPs may find it helpful to have written instructions available below the video tutorials.
<b>PCPs suggest a multi-faceted approach to promote the adoption of video tutorials for EMR optimization.</b>	PCPS think it would be helpful for physician support organizations such as the Divisions of Family Practice and Pathways to host and create awareness of the EMR video tutorials.
	Financial and continuing professional development (CPD) incentives may help PCPs to adopt the EMR video tutorials.
	PCPs would like additional end-user support sources to supplement the EMR video tutorials (e.g., follow-up reminder, in-person training, coaching, an online forum, etc).
<b>PCPs have experienced numerous barriers to integrating the EMR video tutorial training</b>	Lack of time is the biggest physician-level barrier to integrating the EMR video tutorial training into practice for PCPs.
	Some PCPs chose not to use the "recalls" or "ordering labs" features for all their diabetic patients, due to the individual

Theme	Main Findings
<b>into practice.</b>	needs of their patients. PCPs have experienced many staff-level, patient-level, EMR-level, and policy-related barriers to integrating the EMR video tutorials training into practice. Several months after watching the EMR video tutorials, it was difficult for PCPS to remember what the training had covered.
<b>PCPs have experienced numerous facilitators to integrating the EMR video tutorial training into practice.</b>	Using the diabetes flow sheet and chronic disease management (CDM) incentive fees are the biggest physician-level facilitators to integrating the EMR video tutorial training into practice for PCPs. PCPs have experienced many staff-level, patient-level, EMR-level, and policy-related facilitators to integrating the EMR video tutorial training into practice.
<b>In addition to the EMR video tutorials, PCPs receive EMR end-user support from many sources.</b>	PCPs receive the majority of their end-user support from personal support sources (e.g., colleagues, OSCAR Service Provider, Super-Users, Peer Mentors, Quality Improvement support personnel, family members, etc.). Cost is a barrier to receiving end-user support for some PCPs.

### 6.3.1 PCPs liked the EMR video tutorials

All the participants expressed their liking of the EMR video tutorials in the MD-PET intervention and had a positive reaction to the EMR video tutorials. They liked the EMR video tutorial trainer, did not feel anything was missing from them, and would recommend other PCPs to watch the EMR video tutorials.

#### 6.3.1.1 PCPs had a positive reaction to the video tutorials

All participants had a positive reaction to the EMR video tutorials. For example, according to one participant: “So what I watched was very impressive” (Participant 9). Participants liked the EMR video tutorials for numerous reasons. Specifically, some PCPs liked that the EMR video tutorials were **'short', 'simple', and 'accessible.'** Hosting the EMR video tutorials on YouTube also increased the accessibility of the video tutorials. They found the video tutorials to be a **convenient** way to access EMR training

according to their schedule, as PCPs "could do [the training] on [their] own time"(Participant 6). As such, PCPs appreciated that they EMR video tutorials were accessibly anytime:

“And because of the fact that you can access it anytime on a video, that kind of things. It’s just totally the best way for me, because it’s almost always 9:00 at night that I’m ready to do something like that. And that’s not when you can phone someone and ask. So that’s really good.” (Participant 1)

Several PCPs also found the video tutorials to be **'helpful'**, and **supporting effective visual learning** by showing 'on-screen' actions "because it’s nice to see them go into the EMR and click on what we need to click on” (Participant 13). Some PCPs also found the video tutorials to be a good **reference or review** because of the ability "to go back to [the EMR video tutorials]” (Participant 4), especially when "you forget something you don’t use very often, if you forget” (Participant 4).

### 5.3.1.2 PCPs liked the EMR video tutorial trainer

Many PCPS expressed their liking of the EMR video tutorial trainer. They found him to be a **'clear'** communicator. According to one PCP, the [EMR video tutorial trainer] "was very enthusiastic and very clear and very supportive. I thought he was an excellent person. He spoke slowly, he was fantastic. He showed things, I thought it was very effective" (Participant 3). Participants also considered the EMR video tutorial trainer to be a knowledgeable **'expert of experts'** who is a **'good spokesperson'** for PCPs.

### **6.3.1.3 PCPs did not feel anything was missing from the EMR video tutorials**

All participants were pleased with the content of the EMR video tutorials, and did not think anything was missing for diabetes care, as it was 'thorough', 'well done' and "hit on everything [PCPs] would need for diabetes management" (Participant 6).

### **6.3.1.4 PCPs would recommend other PCPs to watch the EMR video tutorials**

Participants universally stated that they would recommend other PCPs who use OSCAR EMR "to watch the [EMR video tutorials]" (Participant 3).

## **6.3.2 PCPs would like more EMR video tutorials**

Participants would like to receive more EMR video tutorials to support their increased use and optimization of the EMR.

### **6.3.2.1 PCPs would like short, online EMR video tutorials on a breadth and depth of topics to support PCPs at different EMR use levels and in different communities**

PCPs commented that they would like EMR video tutorials that, similar to MD-PET, are **short**: "...two to three minutes, and even shorter if possible so [PCPs] can figure out how to do something step-by-step...and have it organized in a way that could be searchable as well" (Participant 2). Participants would also like the video tutorials to be publically available **online**. One participant had actually commented on the fact that the video tutorials in the research study were not publicly available on YouTube (i.e., they were private videos).

Although PCPs appreciated MD-PET, they would like EMR video tutorials on **additional topics**, such as 'other chronic diseases like COPD' (Participant 5), 'determining an active medication list' (Participant 13), and developing 'forms' and 'your own smart labs' (Participant 2). Several PCPs also emphasized the need for having more video tutorials available for PCPs who are at **different EMR use levels**:

"No, I think they're good. You just need more. You need a whole batch of them with an index that physicians can go to get what they're missing. Because all of the physicians are at different levels of their comfort with the EMR." (Participant 2).

Another PCP also suggested that the video tutorials be developed to correspond to the MU levels: "I think the MU3, just keep building on that. Have MU4, have it so we can sign up, watch video tutorials, have our staff watch video tutorials..." (Participant 4). To support PCPs in different communities, a participant also recommended that video tutorials be developed for **different communities** in BC because "each community may have a different way of doing things, and makes the [EMR video tutorials] not useful to them." (Participant 11).

### **6.3.2.2 PCPs would like a searchable library of EMR video tutorials**

Although participants would have liked more EMR video tutorials, they preferred them to be available as a searchable **library** that is "organized and...searchable so that somebody can just say "run reports" or "run diabetes report" and it would flick right to there" (Participant 2) because "physicians use stuff that saves time but they won't use [the EMR video tutorials] if it's more time-consuming" (Participant 2). PCPs would also

find it 'even more helpful' if the library could be **embedded within the EMR** to increase accessibility at the point of care. For example, PCPs could "go to the help button and it [would have] all the list of the tutorials" (Participant 13).

### **6.3.2.3 PCPs think it may be helpful to develop EMR video tutorials for medical office assistants**

To support their Medical Office Assistants (MOA) with increasing EMR use, PCPs suggested developing EMR video tutorials for MOAs because they would be 'very helpful' and "MOAs would really appreciate it" (Participant 3).

### **6.3.3 PCPs think it is important to have a PCP involved in the design and development of EMR video tutorials**

To ensure credible and trustworthy EMR training, participants highlighted the importance of having a PCP involved in the design and development of EMR video tutorials.

#### **6.3.3.1 PCPs prefer to have a practicing PCP involved in the design of EMR video tutorials to develop short and simple learning content that is appropriate for the audience**

To design develop EMR video tutorials, participants prefer to have a practicing PCP to be involved who uses OSCAR EMR, is an 'EMR specialist', and "is aware of what the EMR can and cannot do" (Participant 5). In addition to having knowledge, homophily, counseling, and communication skills, the PCP should know "how to do

things quickly and efficiently or offset the work to MOA" (Participant 9). The PCP should also be "somebody with a very simple message. Very practical, demonstrating the skills...and not talking too much, just very direct and about the message you want to, the skill you want to get across" (Participant 5).

Additionally, participants expressed the importance of having 'short', 'simple', 'basic', and 'very straightforward' content in the EMR video tutorials, as "[PCPs] don't have that much time"(Participant 5). To ensure that the video tutorials are 'more helpful', one participant also emphasized the importance of "breaking down the different [EMR features/tasks], not having it all be in one video" (Participant 5). The EMR video tutorials should also have clear learning outcomes, and outline "what is the skill you are learning, or should feel comfortable after the tutorial, of implementing" (Participant 15).

### **6.3.3.2 PCPs would prefer a well-spoken, professional, engaging, and credible physician trainer who is an experienced EMR user that they can trust and relate to**

Participants highlighted the importance of having a physician trainer who is **well-spoken**, can 'communicate effectively', uses appropriate humor, is 'concise', and 'to the point.' In terms of communicating, the physician trainer should be "speaking softly" and "enunciating their words" because "these things are important" (Participant 5). Further, the physician trainer should be engaging, as "it's got to be lively, entertaining, well-presented, clear, short" (Participant 7). For participants, having a physician trainer 'always lends credibility', increases PCPs' **ability to relate** to the trainer and **trust** the EMR training, because "they understand, you know, [PCPs'] time constraints, and sort of

the busy-ness of doing a practice" (Participant 5). One participant described in detail this expected homophily with the physician trainer:

"So the more information that I find out that the person has in common with my situation, the more likely I am going to think they have something to offer me. So if I'm a community physician, you tell me this person is a community physician, and then I will probably listen to him more than if you told me somebody was a university lecturer. Because I'm thinking, how often do they use the system? Do they run into the same problems I do? And how much are they speaking to my level of function. So you have to target it to your audience." (Participant 11)

Several participants also suggested value in being able to access the **biography** of the physician trainer to know "the background of trainer, which physician in which location" because it "would probably be interesting for the person learning" (Participant 15).

#### **6.3.4 PCPs have visual preferences for the production and presentation of the video tutorials**

To support the visual learning preferences, PCPs indicated that they would like: (a) the EMR video tutorials to use on-screen navigation, (b) to see the trainer in the video, and (c) have written instructions available below the video tutorials.

#### **6.3.4.1 PCPs would like to continue seeing the on-screen EMR navigation in the video tutorials**

In terms of the design of the video tutorials, PCPs liked the on-screen EMR navigation (e.g., highlighting of the chart) and would like to continue seeing it in EMR video tutorials because it is "very useful" (Participant 15) and "helps you to focus your eyes where you're going...and circling the things you're supposed to go to" (Participant 11).

#### **6.3.4.2 PCPs would find it valuable to see the trainer in the EMR video tutorials to increase the audience's connection with the trainer**

To increase their 'connection' and ability to relate with the trainer, several PCPs indicated that they would like to see video of the trainer's face and not just their audio (i.e., voice) because "[PCPs] seem to relate better to faces than to words. So it's nice having the person's face in the corner [of the EMR video tutorial screen]" (Participant 15).

#### **6.3.4.3 PCPs may find it helpful to have written instructions available below the video tutorials**

As a visual supplement and reference, two PCPs stated that they may find it helpful to have written instructions (e.g., step-by-step instruction about how to record a blood pressure in the EMR) available below EMR video tutorials. This would allow PCPs to watch the video tutorial or to read the written instructions "like a recipe" (Participant 2). As such, the viewer "can watch the cook make it or [they] can read the instructions

below" (Participant 2). As in cooking video tutorials with recipes provided in the video descriptions, viewers "can have a choice...[they] might watch the video the first time but then the second time when [they] come back to make that recipe, [they] just want the ingredients and [they] know where to go and what to do" (Participant 2). As per one participant, providing a choice for PCPs to watch the video tutorial or read the written instructions could "be the same for this EMR training" (Participant 2).

### **6.3.5 PCPs suggest a multi-faceted approach to promote the adoption of video tutorials for EMR optimization**

Although all PCPs believed that the video tutorials are a necessary EUS resource, they indicated that EMR video tutorials should be supplemented with other physician supports. Specifically, physician support organizations should create awareness of the video tutorials, incentives should be available for PCPs to adopt the EMR video tutorials, and additional EUS should be provided in addition to EMR video tutorials.

#### **6.3.5.1 PCPs think it would be helpful for physician support organizations such as the Divisions of Family Practice and Pathways to host and create awareness of the EMR video tutorials**

All PCPs suggested that the Divisions of Family Practice and Pathways (i.e., an online, searchable resource for GPs in BC who are members of a Division of Family Practice) would be best suited to (a) host the EMR video tutorials on their websites, and (b) create awareness about the video tutorials:

"Yes, I think you need to be able to find it. So whether all the video tutorials are at the Division website. And then you can go onto the website and access it. Cause when you go

through the videos, like for me, first knowing about them. For me, I know how I work, I would have to have time to look at them. But if I know about them, then I would, I can access them. So it's like UptoDate, I know if I have a question, I can access UptoDate. If I have a drug interaction, I go to ePocrates. If I have a [EMR video tutorial] question, I would go to...the Division website or whichever place where people know where to access." (Participant 5)

### **6.3.5.2 Financial and continuing professional development (CPD) incentives may help PCPs to adopt the EMR video tutorials**

A few participants suggested that **financial incentives** may facilitate adoption of the EMR video tutorials because "in the absence of [financial incentives], there is very little incentive to go and look at [EMR video tutorials] in people's spare time" (Participant 7). **CPD credits** were also suggested as a potential incentive for PCPs to be "more likely to do [the EMR video tutorial training]" (Participant 5). One participant suggested that watching the EMR video tutorials should be a pre-requisite for PCPs to receive incentive billing (e.g., for chronic disease management):

"I think the other thing that would be helpful if this is a direction for the future, and I'm sad to say it, but if it is required in some way or it's linked to being able to do an incentive billing, like if you open up the chronic disease management fees without completing [the EMR video tutorials] so that you have some background information about how to do it, that would also be a very potent motivator. People would complain and be angry but they would actually do it. Because I think the self-directed in your own time is all great but if you do that, for somebody that's very busy, they don't get around to it." (Participant 12)

### **6.3.5.3 PCPs would like additional end-user support sources to supplement the EMR video tutorials**

To supplement the EMR video tutorials, PCPs would like to have access to additional EUS. For example, some participants would appreciate receiving follow-up reminders through the EMR or email to say "hey look at this video, hey remember this training you did, was there anything you needed to implement that you haven't done yet? Do it. Contact us if you need help or something" (Participant 6). Other participants would like to have access to in-person training "because [EMR] training always stimulates more questions, which aren't automatically answered. So, in-person would be great. For like an hour or something" (Participant 9). Individualized coaching was also suggested as an EUS support, as well as online forums "as a place where you can go... if you don't have a person [to go to for EUS]" to ask EMR-related questions (Participant 11).

### **6.3.6 PCPS have experienced numerous barriers to applying the EMR video tutorial training into practice**

Participants have experienced many physician-level, patient-level, staff-level, EMR-level, and policy-related barriers to applying the EMR video tutorial training into practice.

### **6.3.6.1 Lack of time is the biggest physician-level barrier to applying the knowledge gained from the EMR video tutorial training into practice for PCPs**

For many participants, lack of time was the biggest barrier to integrating the EMR video training into practice. According to one participant using the EMR features (e.g., reminders) for diabetes care "takes time" (Participant 13). Consequently, depending on PCPs' time and workload, their use of the diabetes care features fluctuates:

"The only barrier is the time. The only barrier has been the time. So some days I am better at putting disease registry in. Other days, I am busy looking after the patient, so I don't spend as much time on the EMR. On a busy day, I bounce between two routine patients and I end up not recording until the end of the day. So, then those days, the quality of the EMR obviously goes down. On days that I am able to document as I see the patient, it works really well." (Participant 11)

### **6.3.6.2 Some PCPs chose not to use the "recalls" or "ordering labs" features for all their diabetic patients, due to the individual needs of their patients**

Given the individual needs of diabetic patients, some PCPs did not use the "recalls" or "ordering lab" features for all of their diabetic patients. PCPs do not always use the "ordering labs" features for all their diabetic patients "because each diabetic has something a little bit different that [the PCP wants] to order a little bit different lab work" (Participant 2). Similarly, one participant described their patient-specific approach for recalling different patients with diabetes:

"If the patients they come back regularly, I would not use the recall or reminders. But if they were newly diagnosed or they were not as compliant with going regularly, then I

would put in reminders. So it would be more patient-specific that I would put in the recall reminders to ensure they were coming in and getting their blood work." (Participant 5)

### **6.3.6.3 PCPs have experienced barriers at multiple levels to applying the knowledge gained from the EMR video tutorial training into practice**

Participants have experienced **staff-level barriers** to applying the EMR video tutorials to practice, such as 'computer literacy' and "having everybody in the office trained on the same system" (Participant 1). At the **patient-level**, the patient's responsibility in diabetes care was reported as a barrier because "there's a group of people that just aren't going to be responsible" (Participant 4). PCPs also experienced barriers at the **EMR-level**, such as the EMR reminders being a 'pull message' and not a 'push message.' Another barrier related to the EMR "not being as user-friendly as [the participant] would like" due to there being too many clicks (Participant 9). From a **policy** perspective, there are barriers related to PCP funding (i.e., protected time) for EMR use because "[PCPs] are not remunerated for a whole lot of work [they] do in the job. Paper work, labs, referrals, EMR, on and on...there's not funding for that whatsoever. So it's a big barrier" (Participant 9).

#### **6.3.6.4 Several months after watching the EMR Video Tutorials, it was difficult for PCPs to remember what the training had covered**

At three and six months following the MD-PET intervention, several PCPs had **difficulty remembering** what the training had covered because "it was so long ago" and "had largely forgotten the pieces of [the EMR video tutorial training]" (Participant 12). However, one participant shared that they found the Diabetes Care follow-up questionnaires "actually very helpful" because they reviewed "what [the PCP] was supposed to have gotten out of [the EMR video tutorials]" (Participant 12).

#### **6.3.7 PCPs have experienced numerous facilitators to applying the knowledge gained from the EMR video tutorial training into practice**

PCPs have experienced many physician-level, staff-level, patient-level, EMR-level, and policy-related facilitators to integrating the EMR video tutorial training into practice.

##### **6.3.7.1 Using the diabetes flow sheet and CDM incentive fees were the biggest physician-level facilitators to applying the knowledge gained from the EMR video tutorial training into practice for PCPs**

For PCPs, the diabetes flow sheet was a key facilitator to integrating the EMR video tutorial training into practice because "it's so much easier than going through [PCPs'] reams of paper...it's just right there" (Participant 5). **CDM incentive fees** and a 'desire to do good care' were also key facilitators "to adopt the [EMR video tutorials]"

fairly aggressively" (Participant 12). In addition to remuneration, time-savings was another facilitator for one PCP:

“Well, the remuneration we get for looking after a diabetic. It makes looking after diabetes quick, easy, and everything is at your fingertips. So it actually speeds me up. So I earn more money. That's a real motivating factor. For me, [EMR] is a time saver, and it also justified the extra incentive billing that I do.” (Participant 3)

### **6.3.7.2 PCPs have experienced many staff-level, patient-level, EMR-level, and policy-related facilitators to applying the knowledge gained from the EMR video tutorial training into practice**

PCPs' staff have supported integrating the EMR video tutorial training in multiple ways, such as having "an MOA that is dedicated to doing the vitals and show people to their rooms. And bringing up necessary charts, a pre-natal whatever or a WCB form" (Participant 1). Other PCPs have also leveraged "Support from MOAs to spread out tasks" (Participant 9). At the **patient-level**, patients play a facilitating role in diabetes recalls by acting as a 'safety net' so that between the PCP and the patient, "somehow [diabetes follow up care] gets done" (Participant 1).

Participants found that the **EMR** itself served as a facilitator to support integration of the video tutorials into practice, as "[PCPs] can see how in the computer what's been done... which patients are diabetic and what needs to be done, recall and those things" (Participant 14). One participant shared that **policy-related** initiatives such as physician feedback serve as facilitators, as well:

"Well, you know, when we originally developed [incentivized diabetes care], we were actually...we were paying the GPs to collect data. And we would meet and the data, basically your data about the percentage of your patients that were getting out of follow up, was fed back to the doctors. And your line on the graph was compared to your peers. So it was kind of a competitive thing to see who was doing a good job or not. I mean, to get some feedback on success in managing your patients was, we found quite motivating for people to do a better job." (Participant 7)

### 6.3.8 Other Key Qualitative Findings

In the qualitative data, many PCPs shared their beliefs surrounding the role of the EMR in improving diabetes care. Firstly, many PCPs liked that the EMR allows **data to be visualized** to improve the processes of care and clinical indicators for diabetes. For example, "the A1C or the blood pressure will be highlighted red or a different colour. And so [the PCP will] pay more attention to it there" (Participant 14). PCPs also liked the **reminders** available in the EMR to improve the processes of care and clinical indicators for diabetes. Although the quantitative results revealed that PCPs' **ordering of lab work** for stable and unstable patients had decreased for PCPs from O1 to O4, some PCPs still believed that their ability to order lab work in the EMR plays a key role in improving diabetes care: "Even a small thing like ordering the Q3 monthly as a standing order, even that in itself, improves compliance and understanding of the patient's overall health. You know, so it's automatically done" (Participant 3). Finally, some PCPs would like access to more patient information and evidence to support diabetes care management so they can "can go quicker without having to go over to the internet" (Participant 18). Other

participants would like to know "when people go on and off their medications" because it's "not captured well in EMRs" (Participant 18).

The qualitative data also shed light on key characteristics of the PCPs. Prior to the study, some PCPs were already proficient users of the EMR features for diabetes care. As a result, there was less notable change in their EMR use after the study. However, these PCPs still liked the concept of the EMR video tutorials, and thought that they would most benefit new EMR users:

“Because I was already doing a lot of the training, it was not that helpful because I already had been using all the, most of what you trained. I had already been familiar with that. So that’s the only thing. It was not that helpful due to familiarity already.” (Participant 6)

At the same time, the qualitative data also highlighted EMR features that PCPs used following MD-PET, such as the use of recalls. As per one participant, they now "use the [recall] option and that was one of the reasons [they] wanted to have a look at [the EMR video tutorials]" (Participant 18). Further, the qualitative data revealed that many PCPs increased their general use of other EMR features after receiving MD-PET, such as ensuring patients "are being registered in a disease registry appropriately" (Participant 11) and creating templates.

The interviews also revealed that PCPs receive EUS for their EMR from many sources. However, cost is a barrier to receiving EUS for some PCPs. Although PCPs receive EUS from multiple sources, the majority of their EUS comes from personal support sources. One participant described receiving EUS from **quality improvement personnel**, such as PSP:

"And I've also had the benefit of having the PSP, our local person...we went through cleaning up our EMR registry and once we looked at our chronic conditions to see who needs to be called in, who is behind, that kind of thing. So, really have someone sit beside me through this is very helpful. But that's very labour-intensive." (Participant 17)

Another PCP described the EUS they had received from a PITO team member as a part of the provincial MU program, "where somebody actually came to [the PCP's] office and answered [their] questions, for [their] specific EMR, and did the data thing" (Participant 4). According to the participant, the EUS "was amazing and it has lasted," as the PCP has "been using all of those [EMR features] already consistently" (Participant 4).

One PCP also received EUS from their **family member** (e.g., child) who they "can text...and get answers very quickly you know when something doesn't work...or Skype" (Participant 4). Other PCPs have received EUS from **OSCAR EMR meeting and workshops**, and some PCPs received EUS from **colleagues** within their clinic who share their EMR learnings with each other, such as "new ways of doing different tasks in the EMR" and "this is what I'm doing to save time" (Participant 5).

Cost was identified as a considerable barrier for three PCPs to receive EUS. According to one participant, their clinic can only fund basic EUS support from vendor "because it's \$200 per doctor for just the basic support. And anytime [the clinic] need anything changed or done, [they] have to pay \$200 per doctor for NERD, which is the cheapest" (Participant 4). Given the cost of receiving EUS from their OSCAR Provider, PCPs appreciate receiving free EUS from quality improvement programs, such as PSP because "the fact that you don't have to pay for it, it's huge" (Participant 4).

## **Chapter 7: Discussion**

### **7.1 Potential of Video Tutorials to Improve Diabetes Care Processes**

In this research study, the potential of a CCM-based post-implementation EMR training intervention (i.e., video tutorials) was investigated to determine its potential to improve processes of type 1 and type 2 diabetes care management, including (a) use of a diabetes registry, (b) use of diabetes recalls/reminders, (c) ordering/viewing a patient's Hemoglobin A1C every 3-6 months, and (d) recording a patient's blood pressure every 3-6 months. Although video tutorials have recently been applied in a few studies to support EHR training for medical students, medical residents, and nursing students (He, Marquard, & Henneman, 2016; Thiyagarajan, Allen, Peacock, & Cousins, 2017; Zoghbi et al., 2017), the potential of video tutorials to support PCPs or physicians in general has not been widely investigated to date in the literature. Further, the potential of EMR video tutorials that are based on the CCM and best practices for designing video tutorials has rarely been examined.

Previous studies by Thiyagarajan et al. (2017) and Zoghbi et al. (2017) report positive effects of video tutorials for medical students and medical residents. However, the authors used different study designs (a retrospective chart review and a single-institution prospective study, respectively) and did not report the effect size of their video tutorial interventions. In contrast, the mixed methods approach of the efficacy study presented has allowed for a comprehensive examination of the MD-PET intervention. The present study demonstrates a statistically significant increase in EMR feature use for

diabetes care, with a large effect size. While it cannot be concluded that the intervention at O3 has elicited a statistically significant increase in EMR feature use, graphical trends indicate a positive increase in PCPs' use of almost all the EMR features for diabetes care. However, the Hawthorne Effect may have contributed to the positive results in this intervention study (Wickström, Bendix, Scandinavian, & August, 2000). According to the Hawthorne Effect, awareness of being studied may impact behaviour of study participants (McCambridge, Witton, & Elbourne, 2014). As such, the Hawthorne effect is operationalized in three ways: (1) reporting on one's behavior by answering questions, (2) being directly observed, or (3) being made aware of being studied (McCambridge et al., 2014). In the present study, PCPs reported on their behaviour at four time points (O1-O4), which suggests potential for the Hawthorne Effect. In fact, the increase in MCEU score between O1 and O2 (i.e., pre-intervention) for PCPs may be explained by the Hawthorne Effect, as the video tutorials had not yet been introduced to study participants. Further, participants' exposure to the Diabetes Care questionnaire, may be an independent source of change (Evans et al., 2010; O'Sullivan, Orbell, Rakow, & Parker, 2004); PCPs may not have earlier considered questions that were included in the Diabetes Care questionnaire that they completed from O1 to O4. Additionally, given that the Diabetes Care questionnaire is based on the BC clinical practice guidelines for diabetes care, the questionnaire itself may act as a form of intervention, as well. In case there was a Hawthorne effect in the present study, it would be interesting to examine the effects of audit and feedback on PCPs' behaviours.

Regardless, combined with the qualitative results, the quantitative results suggest that the research study had created a statistically significant increase in participating

PCPs' use of diabetes care features. This increase may be due to the fact that that PCPs liked the EMR video tutorials, as was revealed in the PCP interviews at O3 and O4. Similarly, PCPs' liking of the video tutorials and subsequent desire to have access to more EMR video tutorials may also corroborate the statistically significant findings of the quantitative results, suggesting that the possible Hawthorne effect may not be the only reason for the observed change in PCPs' use of EMR features for diabetes care over time. As discussed in the next section, the qualitative findings on barriers and facilitators may help to explain the statistically significant increase in EMR feature use from O1 and O3, and from O1 and O4. For example, the diabetes flowsheet or CDM incentives may have facilitated the application of the EMR video tutorial training to practice.

The role of the CCM (i.e., the model that underpins the MD-PET intervention) in supporting PCPs' change in MCEU scores for diabetes care over time is also of interest. The CCM brings together two professional interventions that have been found to be effective in changing health care professionals' behavior: (1) audit and feedback and (2) reminders (Johnson & May, 2015). In this present study, the MD-PET intervention teaches PCPs how to create a diabetes patient registry, which serves as an "audit and feedback" tool, as the diabetes registry provides a "summary of clinical performance of healthcare over a specified period of time" and is obtained from the patient's medical record (Johnson & May, 2015). Similarly, the MD-PET intervention instructs PCPs how to create recalls/reminders for diabetes care, which serves as "specific information designed or intended to prompt a health professional to recall information or perform or avoid some action to aid individual patient care" (Johnson & May, 2015, p. 2). Johnson & May's (2015) systematic review suggests that interventions based on action (i.e., audit

and feedback, as well as reminders) are more likely to change health care professional behaviour. In this way, the action-oriented topics and skills taught in the intervention itself may have influenced the positive results in the present study. Given the possibility of the various aforementioned extraneous influences in the present real-world study, the findings also align with the systematic review by Renders et al. (2001), which found that multi-faceted interventions for health care professionals (as observed in the present study) facilitate the structured and regular review of diabetes processes of care (Renders et al., 2001).

Although graphical trends indicated a positive increase in PCPs' use of almost all the EMR features, PCPs' ordering of lab work for patients with diabetes appeared to decrease in the present study from O1 to O4. External programs and initiatives designed to reduce lab testing for Hemoglobin A1C (e.g., the Choosing Wisely Canada) may explain the reduced use of ordering lab work for patients with diabetes. For example, following release of the Choosing Wisely Canada guidelines, Arsenau (2016) describes how one Canadian PCP reduced ordering lab work for patients with diabetes from every three months to every six months unless the patient's level is unstable. Similarly, in communicating with the HDC, the researcher learned that key leaders in the BC HDC are promoting the reduction of unnecessary lab testing for chronic diseases, including an OSCAR EMR super-user (T. Monk, personal communication, March 14, 2017). Hence, it is possible that such programs and opinion leaders may have some influence on PCPs' lab ordering behaviour, as observed in this study. For these reasons, the MCEU scores at all four time points were also examined without the metrics for ordering lab work for stable and unstable patients with diabetes. The second rANOVA also showed that the MD-PET

intervention elicited statistically significant changes in use of diabetes-related EMR features (excluding ordering lab work) over time,  $F(3, 51) = 9.276, p < .001$ , partial  $\eta^2 = .353$ . Further, the exclusion of the EMR features related to the diabetes lab ordering feature revealed a larger effect size as compared to including the lab ordering features (i.e.,  $\eta^2 = .353$  vs.  $\eta^2 = .286$ , respectively).

While this small-scale efficacy study demonstrates the potential of CCM-based EMR video tutorials to improve MCEU for chronic diseases such as diabetes, a larger-scale effectiveness study with a control group needs to be conducted to validate the study findings and effect size, as well as determine the generalizability of the study findings.

## **7.2 Barriers and Facilitators to Applying Video Tutorials**

This study found multiple barriers and facilitators to applying the EMR video tutorial training to practice at the physician, staff, patient, EMR, and policy levels. Almost all of these barriers and facilitators align with the "barriers to and incentives for change at different levels of healthcare" identified by Grol & Wensing (2004), including the innovation, individual professional, patient, social context, organizational context, and economic and political context.

In the present study, lack of time (i.e., an organizational context barrier relating to capacities and resources) was the biggest barrier to applying the video tutorials to practice. This aligns with previous literature indicating that PCPs require more time for recommended CDM than is available for patient overall (Ostbye et al., 2005), as well as time as a barrier to adopting EHRs (Ajami & Bagheri-Tadi, 2013; Shuval et al., 2007).

The barrier of individual patient needs maps to the "patient" level barrier of Grol & Wensing's framework. It also aligns with research on the need for individualized diabetes management instead of a "one-size-fits-all" approach (Bailey et al., 2013) and consideration for comorbidities (e.g., patients with diabetes and chronic kidney disease) (Levey & Coresh, 2012). However, at the same time, the patient's knowledge and compliance act as a barrier and facilitator, as identified in the present study.

The staff-level barriers and facilitators reported in this study relate to the organizational context and are consistent with earlier barriers and facilitators discussed in the EHR adoption literature (Ajami & Bagheri-Tadi, 2013; Whittaker, Aufdenkamp, & Tinley, 2009).

At the EMR-level, the benefits and challenges reported by PCPs also correspond with the EHR adoption and use literature, and align with the "innovation" level described by Grol & Wensing (2004). Issues with OSCAR EMR's functionality and usability may affect its: (a) advantages in practice, (b) feasibility, (c) credibility, (d) accessibility, and (e) attractiveness (Grol & Wensing, 2004). As such, EMR functionality and usability are also significant barriers identified in the EHR adoption literature (Ajami & Bagheri-Tadi, 2013). However, the video tutorials themselves are also at the "innovation" level. Given the credibility, accessibility, and attractiveness of the video tutorials found in this study, it is suggested that the characteristics of the EMR video tutorials themselves serve as a facilitator for their application in PCPs' practice.

The policy-related barriers (e.g., lack of funding or remuneration) identified in the present study correspond with the "economic and political context" level of Grol and Wensing's (2004) framework. Financial incentives have been long been identified as an

EHR adoption barrier (Ajami & Bagheri-Tadi, 2013). Because financial incentives align with economic theories that can influence the volume of specific activities (Grol et al., 2013), the financial barriers identified in the present study may help explain variation in PCPs' EMR use for diabetes care.

Although this efficacy study demonstrates the potential of video tutorials to be used for post-implementation EMR training for PCPs, it should be noted that, for many EMR features, there has been a slight decline from the first post-intervention measurement (O3) to the second (O4), and that many PCPs found it difficult to remember what the training had covered several months after watching the EMR video tutorials. There may be several reasons for this recall issue. The follow up period for PCP interviews (3 months and 6 months) may be too long. Alternatively, although video tutorials can reduce cognitive processing for immediate practice (Palaiogeorgiou & Despotakis, 2010), the "mimicry model" and lack of inferential step (as in text-based tutorials) limitation of video tutorials may reduce the retention of skills (Harrison, 1995; Palmiter & Elkerton, 1991). Additionally, video tutorials may undermine learning outcomes due to less activated and engaged learners (Ertelt, 2007; Palmiter & Elkerton, 1991). It is also possible that PCPs may not be actively or adequately practicing the EMR skills taught in the video tutorials, suggesting that they have not fully adopted the training into practice.

### **7.3 Relationships between PCP Characteristics**

To test the relationships between PCP characteristics, Kendall's tau-b correlations were calculated. Three pairs of PCP characteristics had a strong and positive association, which was statistically significant: (1) age and years of practice, (2) years of experience

using OSCAR EMR and number of EMRs used, and (3) computer skills and EMR skills. Given that these correlations can cause the problem of discriminant validity, only one variable from each pair was considered for inclusion in the regression analyses in order to prevent multicollinearity. For future research, valid and reliable measurement instruments with continuous variables should be employed in collecting PCPs' demographic information. Additionally, voluntariness of system use (Venkatesh, Morris, Davis, & Davis, 2003), practice size, number of practice hours per month, average number of patients seen daily, and country of training should be considered as physician characteristics in the demographic questionnaire. Publicly-available information on physicians' financial billings (or self-reported PCP income) may also be considered to test additional relationships between PCP characteristics, such as years of experience using OSCAR EMR and PCP income.

#### **7.4 Effect of PCP Characteristics on EMR Use for Diabetes Care**

In the present study, Kendall's tau-b and Pearson's correlation coefficients were calculated for PCP characteristics and the baseline EMR use scores at O1. Number of EMRs used was strongly and negatively correlated, whereas age and years of practice were moderately and positively correlated with the EMR use score for diabetes care at O1. To prevent multicollinearity, years of practice was included in regression analyses instead of age. The multiple regression model statistically significantly predicted EMR use for diabetes care,  $F(3, 14) = 3.80, p = .04, R^2 = .45$ . Only one variable (years of practice) added statistically significantly to the prediction,  $p = .05$ .

In general, graphical trends indicate that PCPs with the following characteristics had higher increases in mean composite EMR use (MCEU) score for diabetes care from O1 to O4: (1) being female, (2) being aged 35-44, (3) being from Vancouver Island, (4), having less than 4 years of medical practice, (5) having 3-4 years of EMR experience, (6) having 1-2 years of OSCAR EMR experience, (7) using four EMRs, and (8) having prior post-implementation EMR training. Some of these findings are in contrast with the Unified Theory of Adoption and Use of Technology (UTAUT) (Venkatesh et al., 2003). According to the UTAUT, facilitating conditions (i.e., EUS such as video tutorials) only have a significant effect for older people in the later stages of experience. However, in the present study, MD-PET appears to have had the greatest effect on younger PCPs at the earlier stages of their medical careers, although the sample is too small to provide sufficient power for testing the statistical significance of this finding. Yet, the present study may have some congruence with the findings of Venkatesh et al. (2003) about "effort expectancy" and "social influence" having a stronger effect for women and those with limited experience. This may explain why female PCPs, PCPs with low EMR skills, and PCPs with less OSCAR EMR experience had a higher increase in MCEU score from O1-O4 in the study. However, it is important to also consider the role of ceiling effects, as they have been found to limit EMR use scores (Price et al., 2013). Additionally, although one may expect a PCP who has used multiple EMRs to have stronger EMR skills and EMR use, this was not the case in the present study. It is possible that use of multiple EMRs may limit PCPs' proficiency in using each EMR. This is an area that warrants further investigation.

In terms of physician characteristics, another important consideration is the characteristic of the PCPs who volunteered to participate in the study. Given that many physicians may prefer a pragmatic approach (Grol et al., 2013; Mammen et al., 2007; Nylenna, Aasland, & Falkum, 1996; Owen et al., 1989), it is possible that the PCPs who participated in the present study considered MD-PET to be a pragmatic training intervention. That may explain their receptivity to applying the learning from the video tutorials into practice over the duration of the study.

Another related concept is the characteristics of the individuals who may adopt a change, as per Diffusion of Innovations theory (Rogers, 1995). Given that all but one PCP in this study have used an EMR for over three years, the majority of the study participants appear to be EMR early adopters or early majority. As such, they select ideas that they would like to try out, are locally well-connected socially, test several innovations at once and can report on them if asked, and are "self-conscious experimenters" (Berwick, 2003). This may explain the PCPs' willingness to participate in the study, test out the video tutorial intervention, and provide feedback. Interestingly, many of the participating PCPs also shared that the content from the video tutorial training was not new for them, thereby suggesting that they may be early EMR adopters. However, it is important to consider these comments in light of the Hawthorne Effect and Social Desirability Bias, as it is possible that some of the participants may have desired to be viewed favorably (e.g., as early EMR adopters or early majority) in the research. Further, their participation in the study suggests that the PCPs may also be early EMR video tutorial adopters.

## **7.5 Implications of the Findings**

### **7.5.1 Implications for the Design and Delivery of Video Tutorials**

The qualitative results help to identify opportunities to improve the design and delivery of EMR video tutorials for future training interventions. This includes the development of an EMR video tutorial library, continued use of physician trainers in the design and development of EMR video tutorials, use of a multi-faceted EMR training strategy, and provision of incentives to support adoption of video tutorials by PCPs. For future development and deployment of video tutorials, PCPs have suggested a multi-faceted approach that includes additional EUS to promote the adoption of EMR video tutorials. To support future design and development of EMR video tutorials, PCPs would like to have a PCP involved in the development of the video tutorials. This aligns with the concept of homophily as a characteristic of EUS (Shachak et al., 2011). It also corresponds with Social Learning Theory, in which the teacher (i.e., physician trainer for the video tutorial) models a new behaviour while providing learners with the opportunity to practice the behavior (Bandura, 1977, 1986; Grol et al., 2013; Torre, Daley, Sebastian, & Elnicki, 2006). Further, modeling behaviour has been shown to increase the adoption of the modeled behaviour by individuals, especially if the model is similar to the individual(s) (Bandura, 1986). As such, modeling may be considered similar to the concept of homophily in EUS described by Shachak et al. (2011). Eyal and Rubin (2003) further extended Bandura's Social Learning Theory by identifying three essentials for learning: (1) homophily (similarity between the observer and observee), (2) identification (ability of the observer to engage in perspective taking and share in the observee's experience), and (3) parasocial interaction (friendship or bond with the observee). These

three learning 'essentials' highlight potential similarities with the present study's findings related to PCP preferences for (1) having a physician trainer, (2) knowing the biography of the physician trainer, and (3) seeing the face (video footage) of the physician trainer in the EMR video tutorial.

Additionally, PCPs emphasized the need to support visual preferences in the production and presentation of video tutorials. This visual preference may correspond with dual coding theory, which suggests that visual images, coupled with verbal information, aid learning (Paivio, 1971). Another important consideration in video tutorial development is the use of relevant theory such as the CCM to ensure a theoretical foundation for designing video tutorials for post-implementation EMR training. For this reason, relevant theory should be reviewed in the conceptualization and design of future EMR video tutorials.

### **7.5.2 Implications for Stakeholders**

For **policy makers**, the demonstrated efficacy of the EMR video tutorials suggests that EMR video tutorials may be a cost-effective, sustainable, and scalable strategy for supporting EMR optimization in BC, Canada, and beyond. As such, it may be valuable to invest in the development of EMR video tutorials for PCPs. Specifically, there is a need to develop an EMR video tutorial library as an open educational resource (OER) (United Nations Educational Scientific and Cultural Organization, 2017) for PCPs for all EMRs, which can be hosted on an accessible website such as YouTube channel. For medical trainees, the BCcampus (BCcampus, n.d.) open education website may be

leveraged to host EMR training content. Although it would require an initial investment to develop the EMR video tutorials, there would likely be low maintenance or ongoing costs to support the EMR video tutorial library. Potential funding or CME accreditation for PCPs to watch the EMR video tutorials during protected time should be considered as well. Also, programs such as the PSP in BC may consider including EMR video tutorials as a supplementary EUS resource in the design of their EMR learning strategies for PCPs. The development of EMR video tutorials for MOA's, as suggested by study participants, should also be considered.

To support testing of the video tutorials prior to large scale dissemination to PCPs, it would be valuable to recruit PCPs who are advanced EMR users and have interest in providing feedback to improve the quality of the video tutorials. Specifically, "improvement fellowships" may be created to provide financial support to PCPs who are interested in supporting the design and development of EMR video tutorials. Additionally, the role of the Hawthorne Effect or Social Desirability Bias should also be leveraged through regular follow up and feedback (e.g., self-report of EMR use or through an objective EMR data report) to improve PCPs' value-adding EMR use.

In terms of implications for **physicians**, this study has demonstrated the efficacy of an emerging learning strategy to support the continuous learning and development of PCPs. PCPs may seek EMR video tutorials as an effective and inexpensive medium to optimize their EMR use. They may also use the EMR video tutorials to train their office staff, as well as medical residents and locum physicians.

Given the demonstrated efficacy of the video tutorials, **vendors** may wish to develop video tutorials for their respective EMR/EMR software based on theory and best

practices for video tutorial design. For **patients**, EMR video tutorial interventions such as MD-PET may lead to improved tracking of processes of care for diabetes, which may have some effects on patient outcomes.

## **7.6 Study Limitations**

There are a number of limitations to this research study. The study was a within-group quasi-experiment without a control group, which limits the internal validity of the study. Another key study limitation is the small sample size, and that a convenience sample was used (i.e., participants self-selected to participate). The small sample size also resulted in small n's for some of the subgroups in the statistical analyses. As a result, it is not surprising that many of the two-way mixed rANOVAs did not yield significant interaction effects. Additionally, the small sample size reduces the external validity of the study. The small sample size may be due to lack of funding or CME to support and compensate PCPs' for the time to participate in the study. Participant recruitment was also done over the summer, which is considered to be a difficult time to contact physicians due to summer vacation/holidays. In the future, participant recruitment should be considered before or after the summer season.

The post-intervention follow-up period was also a limitation of the study, as it was also only six months in duration. A longer follow-up period may have allowed for the post-intervention efficacy of the video tutorials to be better examined. Also, it would allow for time-sensitive annual diabetes process measures (e.g. eye exams and foot exams) to be evaluated for PCPs' patients. Further, patient health outcomes were not examined in the study, which is recommended by Renders et al. (2001). Future studies

should examine patient health outcomes as important measures in Donabedian's Structure-Process-Outcome Model.

In terms of developing the EMR video tutorials, this was the first time that the researcher and Physician Champion had developed video tutorials. This may have affected the professional quality of the video tutorials. Additionally, the intervention did not include a "hands-on" practice component, which is recommended by van der Meij and van der Meij (2013) in best practices for the design of video tutorials (i.e., Guideline 8: Strengthen demonstration with practice). Beyond use of self-report in the Diabetes Care questionnaire, it was also not possible to validate if PCPs had watched the video tutorials. Future research should consider mechanisms to validate that PCPs have fully watched the EMR video tutorials (i.e., fully received the intervention).

Additionally, data collection was based on self-report by PCPs. Future research should include objective EMR data (e.g., EMR usage statistics or EMR data dashboard). In addition, as a part of data collection, many of the study variables were categorical and ordinal instead of interval or continuous data, which limited the statistical analyses possible. For this reason, Kendall's tau-b had to be used instead of Pearson correlation, for example. Additionally, a repeated measures ANCOVA to test the significance of some PCP characteristics (e.g., age and EMR skills) on EMR use for diabetes care could not be conducted due to the small sample size and study variables being categorical or ordinal instead of interval or continuous variables.

## 7.7 Directions for Future Research

The present study suggests several directions for future research. EMR video tutorials should be designed with (a) a PCP Champion, (b) using theory that underpins the EMR training intervention, and (c) full application of all the best practices for video tutorial design from van der Meij & van der Meij (2013). The effectiveness of EMR video tutorials should be examined using process measures and outcomes measures for Level 4 and Level 5 functions of BC's Clinical Value Model for EMRs (or alternate EMR use models in other Canadian provinces), as well as the New World Kirkpatrick Model. Randomized control trial (RCT) or a quasi-experiment with a control group with a large sample size and objective EMR data should be employed to establish validity. It will be important to verify the trends identified in this study through a larger comprehensive study. Also, a RCT approach may be used in order to isolate the effect or impact of the EMR video tutorial training itself. As such, one group of PCPs would receive the EMR training intervention, while a matched group would not receive the intervention or instead receive a lecture-style educational intervention. Both groups can then be studied over time. The study could also be extended to compare different levels of EMR training. A quasi-experimental design may also be used with a control group to investigate the effectiveness of EMR video tutorials. In future research, demographic data should be collected using continuous or interval variables and a valid and reliable questionnaire. In addition, the effects of EMR video tutorials can be studied as a part of a multi-faceted EMR learning strategy (e.g., EMR video tutorials, in-person training, and follow up reminders).

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# Appendix

**Appendix A:** Video Tutorial Script

**Appendix B:** Video Tutorial Link and Screenshots

**Appendix C:** Study Invitation Letter

**Appendix D:** Study Consent Form

**Appendix E:** Demographic Survey and Diabetes Care Questionnaire

**Appendix F:** Interview Guides for O3 and O4

**Appendix G:** Qualitative Data Codebook

**Appendix H:** Health Data Coalition Letter

## Appendix A: Video Tutorial Script

### Diabetes Care Management: Video Tutorial Series Script (OSCAR EMR version 13)

*Prepared by Gurprit K. Randhawa and Dr. John Yap*

#### van der Meij & van der Meij (2013) Guidelines for Video Recording:

- Employ a conversational tempo
- Speak instructions slowly

#### Video 1: Coding Diabetic Patients in OSCAR EMR

[Record/show Dr. Yap]

Hi, I am Dr. John Yap, an OSCAR EMR Super-User. This simply means I have been using Oscar for a long time, and I've stumbled onto some very useful shortcuts and features. In this video, I am going to show you how to code your diabetic patients to create a **diabetes registry** and how to add the diabetic label to the Cumulative Patient Profile (CPP) in OSCAR versions 12 and 15. For more information about the benefits of creating a diabetes registry, please refer to the video description below this video.

Let's look at how to create a diabetes registry in your EMR.

[Show OSCAR interface preview with a 0.5-2 second pause]

To code a patient as a diabetic patient, you must first access their electronic record or E-chart [zoom in, show action]. Next to the Disease Registry [circle mouse around Disease Registry module], click on the + (plus sign) [circle mouse]. to add or edit a Disease Registry item [zoom in, show action]. Under the "Coding System," ensure that "ICD9" is selected [show action]. If not, select "ICD9" from the dropdown menu now. Next, type "250" and click "Add" [show action]. You can update, resolve, or delete disease registry items in the future using the EDIT functions here [Hover over appropriate links]. That's it! We've now added the patient to the diabetes registry.

[Show E-Chart Screen, 0.5-2 second pause]

Now, let's close the registry and refresh the patient's chart. This is done by clicking the F5 button, or right-clicking your mouse. Now the latest changes you have made are

displayed. You can see that the diabetes flowsheet has been added to the measurement module [circle mouse around Measurement module]. The DM flowsheet summarizes a number of diabetes-related parameters. We will review how to record diabetes measurements (e.g., A1C and blood pressure) in another video.

After coding your diabetic patient with 250 in the Disease Registry, you should also make an appropriate comment in the CPP area [hover over CPP]. I will demonstrate one way you might identify the diabetic patient in their CPP. Information in the CPP is meant to capture highlights of the patient’s bio-psycho-social health – a chart summary “at a glance”. This information can be readily transferred to consultation letters and certain eForms (templates).

[0.5-2 second pause]

Let’s add diabetes to the CPP. On the right side of the “Medical History” bar, click the + (plus sign) to create a new entry [zoom in, show action]. Each time you click the plus sign, a new bullet point is started. You can group items together in a bullet, or separate each item. If you use an acronym, please ensure it is generally recognizable. I prefer to be brief and succinct. I am going to type in “T2DM’13” to indicate that the patient has type 2 diabetes with an onset date of 2013 [zoom in, show action]. Click on the “sign and save” icon to keep your changes. Click on the bullet hyperlink to see the entire contents in a separate window. Click on the “exit” icon to close the window without saving your changes.

In this video, you learned how to create a diabetes registry. The next video will show you how to create diabetes recalls and reminders in the EMR.

## Video 2: Creating Diabetes Recalls in OSCAR EMR

[Record/show Dr. Yap]

Hi, I am Dr. John Yap, an OSCAR EMR Super-User. This simply means I have used Oscar long enough to find short cuts to share with others. If you discover a helpful shortcut, please share it and you, too, can be a Super User. In the previous video, I showed you how to add a patient to the diabetes registry and how to add diabetes information to the CPP. In this video, I am going to show you how to create **diabetes recalls (reminders)** for your diabetic patients. For more information about the benefits of creating diabetes recalls, please refer to the video description below this video.

[Show OSCAR interface preview with a 0.5-2 second pause]

In OSCAR EMR, you can create diabetes recalls in two ways: (1) Using OscarMsg (internal email) and (2) Using Ticklers (scheduled reminders). Let's walk through both approaches.

[Highlight OSCARmsg module] OSCARmsg is essentially an internal eMail system connecting all users of the Oscar EMR.

Let's send an OSCARmsg to the MOA.

**From within the patient's eChart**, click the + (plus sign) to open a message window [zoom in, show action]. Add relevant details to the "Subject" and message fields. Choose a recipient for the OSCARmsg from the list. The message can be sent to multiple recipients, including yourself, if you need a reminder, such as to book a diabetic follow-up visit in six months [zoom in, show action]. To send the message, click "Send Message" [zoom in, show action]. The recipient is notified of unread messages on their schedule page. For tips to help MOAs with handling the task, please refer to the video description below. That's it! We've now created a diabetes recall using OSCARmsg.

[Show E-Chart Screen, 0.5-2 second pause]

Let's now create a diabetes recall using Ticklers, which are essentially scheduled reminders. Let's create a recall Tickler for our MOA. From the patient's eChart, click the + (plus sign) to add a new Tickler [zoom in, show action].

Imagine we have an unstable diabetic patient, and we wish to have him on a short interval recall of 1 month, it is possible to label the message as HIGH PRIORITY for the MOA. Let's create the high priority recall. [zoom in, show action].

Change the service (action) date to the appropriate timing [zoom in, show action]. The Tickler list is sorted by action date, with the closest (or future) action date at the top, the oldest at the bottom. Leave the date as today (default) if you wish the action to be immediate. I'm going to have the MOA remind the patient to book an appointment 2 weeks before his 1 month follow-up. If the patient was more stable, I might let the message pop up after 6 months [zoom in, show action].

Next, I need to assign the Tickler to my MOA. The default assignee is the current user – you. To assign the Tickler to your MOA, click the arrow beside the "Task Assigned To" drop-down list, and select one of the names in the list [zoom in, show action]. You can

only assign a Tickler to one recipient. Type your message in the Reminder Message box [\[zoom in, show action\]](#).

Click the "Submit and Exit" button [\[zoom in, show action\]](#). The new Tickler message will appear after you refresh the eChart, as we reviewed in the first video. That's it! We've now added created a diabetes recall using Ticklers.

[\[0.5-2 second pause\]](#)

In this video, you learned how to create diabetes recalls. The next video shows you how to record Hemoglobin A1C and blood pressure in the EMR.

### **Video 3: Recording Hemoglobin A1C and Blood Pressure in OSCAR EMR**

[\[Show E-Chart Screen in OSCAR EMR\]](#)

Hi, I am Dr. Yap, an OSCAR EMR Super-User. In this video, I am going to show you how to record Hemoglobin A1C and blood pressure in your EMR. By following these simple steps, you, too, will become an OSCAR Super-User!

The "Measurements" section of the patient's chart [\[circle mouse around over module\]](#), is the BEST place to store data on indicators that change over time. Many of the diabetes-related indicators can be found in the Diabetes flowsheet. As you may recall from the first video, the Diabetes flowsheet is displayed once diabetes (250) is added to the patient's disease registry.

[\[0.5-2 second pause\]](#)

Now, let's add a blood pressure measurement to the diabetes flowsheet. Go to the measurement area and click the DM flowsheet. In the Flowsheet window, click the "BP" button along the left margin to add a new blood pressure reading [\[zoom in, show action\]](#). Add the BP reading in the usual fraction format. Add any relevant comments – but do not use special symbols such as apostrophes, > and < signs, as this will cause a system runtime error. Click "Save" to record your input [\[zoom in, show action\]](#). That's it! We have now added a new measurement. If you would like to see a display of the BP trend, click on the graph icon.

From the "Diabetes flowsheet" screen, you can manually record a Hemoglobin A1C by following the same steps. Please note that if you receive labs from Excelleris, A1C will

automatically populate this area. Contact your Oscar Service Provider if this is not working as expected.

On the flowsheet, you will also note that some Measurements are highlighted in red. This indicates a measurement may be overdue [\[zoom in, show action\]](#). **You can create a list of the red-flagged items by clicking on the Show/Hide hyperlink at the top of the flowsheet** [\[zoom in, show action\]](#). The actual measurements are also color-coded. For example, Red indicates a measurement that is severely out of range while orange indicates that it is moderately out of range.

In this video, you learned how to recording Hemoglobin A1C and blood pressure in the EMR. The next video reviews how to quickly order lab tests for diabetic patients, such as Hemoglobin A1C.

#### **Video 4: Ordering Diabetic Lab Testing in OSCAR EMR**

[\[Show E-Chart Screen in OSCAR EMR\]](#)

Hi, I am Dr. Yap, an OSCAR EMR Super-User. If you use the smart lab requisition, then you are also a Super User! In this video, I am going to show you how to create lab tests for diabetic patients, such as **standing order for A1C checks**.

The lab requisition is found in the patient's eForm library [\[zoom in, show action\]](#). If you do not have the smart lab requisition, please ask your Oscar Service Provider to install it for you. This is a very unique feature of OSCAR EMR. Let's explore this feature closer by going to the eForms banner and clicking the + (plus) sign [\[zoom in, show action\]](#).

Now click on "1.1 Lab Requisition."

The requisition is SMART because previous lab results are displayed with easy links to see the cumulative report of each item. Consider the yellow-highlighted items as they may be overdue for your patient.

On the right side, there is a "quick pick" menu showing various lab pre-sets [\[zoom in, show action\]](#).

Let's create a lab requisition that allows the patient to attend for A1c checks every 3 months – a standing order. Just click "A1C-3QM" [\[zoom in, show action\]](#). That's it!

Now, let's click "Print and Submit" to finish. [zoom in, show action]. Feel free to explore the other quick pick menu items and hyperlinks in the lab requisition.

[0.5-2 second pause]

It's just as easy to order the entire Diabetes Management lab bundle. Let's try doing that now. Click "Reset" at the bottom of the requisition form or simply start from scratch with a fresh 1.1. Lab Requisition eForm [zoom in, show action]. Click "Annual" or "Standing Order" based on your ordering preferences [zoom in, show action]. Now let's click "Print and Submit," which will send the lab requisition to your printer.

[0.5-2 second pause and show recording of Dr. Yap]

In this video, you learned how to order diabetic lab testing in the EMR. This is the last video of the Diabetes Care Management video tutorial series for OSCAR EMR. I hope you found the training valuable. Please practice using the diabetes care management features introduced in this video tutorial series using your EMR.

[0.5-2 second pause]

If you have not already done so, please also complete the Diabetes Care Management Survey that was emailed to you with the link to this video tutorial series. Thank you for your time and attention.

## **Appendix: Video Descriptions (for the area below the YouTube videos)**

### **Video 1: Coding Diabetic Patients in OSCAR EMR**

Benefits of Diabetes Registries:

A diabetes registry allows you to easily identify the diabetic patients in your practice. In a nutshell, the registry labels your patient as diabetic. The process is simple: in the diabetic patient's chart, you add the "250" International Classification of Diseases (ICD-9) code to the disease registry section. Once complete, the diabetes registry enables you to more easily organize and track a multitude of relevant indicators related to your diabetic patients. It allows you to do deeper analyses of your diabetic patient care, so you can better organize your practice and improve your care. The disease registry enables you to:

- Generate patient lists for you, which can be sorted by age, type of diabetes, A1C or other criteria

- Track when patients were last seen by the physician, what tests they had, and what tests they need
- Track the number of patients achieving their targets, and let you see if changes you implemented improved their care

## Video 2: Creating Diabetes Recalls in OSCAR EMR

### 1. Benefits of Diabetes Recalls:

A well-developed recall system **enables** you to **remind** your patients and caregivers of:

- Timely review and reassessment of diabetic targets
- Need to see relevant specialists (e.g. ophthalmologist, optometrist)
- Future necessary follow up visits.

Having a recall system to remind your patients about timely tests and appointments will help you and your patient comprehensively monitor their diabetes, and make timely adjustments to their care plan as needed. This allows the creation of a road map to quality diabetes care. You can also apply these recall principles to other chronic diseases and areas of care, such as future needs for pap, colonoscopy, repeat mammograms, etc.

### 2. Tips to help MOAs with handling Ticklers:

Although Ticklers can only be sent to one assignee, OSCAR allows users to create virtual assignees for Ticklers. At our clinic, we have created an MOA Tickler account called "MOA, MOA", as the generic MOA account requires a first and last name. If you need to create such an assignee, please ask your Oscar Service Provider (OSP) for assistance.

All of our MOAs regularly check the Tickler page to review the Ticklers assigned to the generic MOA account. The most recently scheduled Ticklers are at the top and are highlighted by priority level. This is the default display – sorted by service date. You can also sort by priority by clicking on the “Priority” heading at the top of the report. Once the task is completed, the Tickler is checked, and moved to the completed pile by clicking on the “Complete” button at the bottom. Also, if the MOA wishes to acknowledge the task, she/he can put in a short note in the chart (e.g., "Pt aware of diabetes follow up-visit on Aug9/17" or "Notified of Diabetes appt July 2/17 @ 11:00 a.m." Clicking on the patient’s name brings you to the patient’s Master File page. Access the eChart by clicking “E-Chart” in the left margin. Writing a brief note in the encounter page ensures the recall actions are easily found when/if the patient calls to inquire.

**Video 3: Recording Hemoglobin A1C and Blood Pressure in OSCAR EMR**

Recording key indicators (A1c, eGFR, Hgb, BP, weight, etc) as measurement data is desirable. This makes the values easier to find (listed in measurement section), and if numeric it can be plotted as a graph. Fortunately, most lab data are automatically added to measurements. Other measurements (vital signs, for example) must be added “manually”. If you input this data into a measurement field, rather than the clinical note, then it can also be similarly tracked and graphed. The data will also populate the relevant flow sheets. Once you save the measurement input, it is pasted into the clinical note, so the information is still easily found in the patient’s chart.

**Video 4: Ordering Diabetic Lab Testing in OSCAR EMR**

The lab requisition in OSCAR has been designed with many features to enhance ease of use and provide clinical guidance. If you have properly coded your disease registry, the lab requisition will suggest relevant tests that may be appropriate and due for your patient. These clinical cues are based on accepted guidelines. It will also identify key lab items that have been checked previously and may not require repeating. The listing of previous lab values is extremely helpful, and provides link to the cumulative report of those items. Finally, pay attention to you estimated cost of the tests ordered, and you will become a better steward of our Health Care resources.

## Appendix B: Video Tutorial (MD-PET) Link and Screenshots

### Video Tutorial Series Link:

[https://www.youtube.com/playlist?list=PLqNVRTDyA\\_99lsQzVXz4K3X8VvZr7oUXZ](https://www.youtube.com/playlist?list=PLqNVRTDyA_99lsQzVXz4K3X8VvZr7oUXZ)

### Video Tutorial Screenshots:

The screenshot shows a web browser displaying a YouTube playlist page. The browser's address bar shows the URL: [https://www.youtube.com/playlist?list=PLqNVRTDyA\\_99lsQzVXz4K3X8VvZr7oUXZ](https://www.youtube.com/playlist?list=PLqNVRTDyA_99lsQzVXz4K3X8VvZr7oUXZ). The YouTube interface includes a search bar, navigation links (Home, Trending, History), and a sidebar with 'BEST OF YOUTUBE' categories like Music, Sports, Gaming, Movies, TV Shows, News, Live, and 360° Video. The main content area features a video player showing a message: "Diabetes has been added to the Patient's Disease Registry!" with a "PLAY ALL" button. Below the player, the playlist title "OSCAR EMR Video Tutorial Series" is displayed, along with "4 videos · 115 views · Last updated on Sep 27, 2017". A "SUBSCRIBE" button is visible for the channel "OSCAR EMR Tutorials". To the right, a list of four videos is shown:

- Video 1: Coding Diabetic Patients in OSCAR EMR (4:26)
- Video 2: Creating Diabetes Recalls in OSCAR EMR (4:48)
- Video 3: Recording Hemoglobin A1C and Blood Pressure in OSCAR EMR (3:41)
- Video 4: Ordering Diabetic Lab Testing in OSCAR EMR (4:06)

The screenshot shows a YouTube video player displaying a video titled "Video 1: Coding Diabetic Patients in OSCAR EMR". The video content shows a man, Dr. John Yap, speaking. A yellow text box on the left says "Hi, I'm Dr. John Yap". At the bottom of the video frame, it says "OSCAR EMR Super-User" with a smiley face icon. The video player includes standard controls like play/pause, volume, and a progress bar showing 0:12 / 4:25. To the right of the video player, the playlist "OSCAR EMR Video Tutorial Series" is visible, listing the same four videos as in the previous screenshot.

Video 1: Coding Diabetic Patie

https://www.youtube.com/watch?v=UZ6hNxiOGsE&list=PLqNVRTDyA\_99lsQzVxz4K3X8VvZr7oUXZ6

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**In this video, you will learn how to:**

- 1. Create a Diabetes Registry**
- 2. Add Diabetes to Cumulative Patient Profile**

0:32 / 4:25

OSCAR EMR Video Tutorial Series  
Unlisted OSCAR EMR Tutorials - 1 / 4

- ▶ Video 1: Coding Diabetic Patie OSCAR EMR OSCAR EMR Tutorials 4:26
- ▶ Video 2: Creating Diabetes Re OSCAR EMR OSCAR EMR Tutorials 4:48
- ▶ Video 3: Recording Hemoglob and Blood Pressure in OSCAR OSCAR EMR Tutorials 3:41
- ▶ Video 4: Ordering Diabetic Lab in OSCAR EMR OSCAR EMR Tutorials 4:06

Video 1: Coding Diabetic Patie

https://www.youtube.com/watch?v=UZ6hNxiOGsE&list=PLqNVRTDyA\_99lsQzVxz4K3X8VvZr7oUXZ6

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OSCAR EMR Video Tutorial Series  
Unlisted OSCAR EMR Tutorials - 1 / 4

- ▶ Video 1: Coding Diabetic Patients in OSCAR EMR OSCAR EMR Tutorials 4:26
- ▶ Video 2: Creating Diabetes Recalls in OSCAR EMR OSCAR EMR Tutorials 4:48
- ▶ Video 3: Recording Hemoglobin A1C and Blood Pressure in OSCAR EMR OSCAR EMR Tutorials 3:41
- ▶ Video 4: Ordering Diabetic Lab Testing in OSCAR EMR OSCAR EMR Tutorials 4:06

Video 2: Creating Diabetes Recalls in OSCAR EMR

Unlisted  
33 views

OSCAR EMR Video Tutorial Series  
Unlisted OSCAR EMR Tutorials - 2 / 4

- Video 1: Coding Diabetic Patients in OSCAR EMR (4:26)
- Video 2: Creating Diabetes Recalls in OSCAR EMR (4:48)
- Video 3: Recording Hemoglobin A1C and Blood Pressure in OSCAR EMR (3:41)
- Video 4: Ordering Diabetic Lab Tests in OSCAR EMR (4:06)

Video 2 Revised  
OSCAR EMR Tutorials  
1 view

Video 3: Recording Hemoglobin A1C and Blood Pressure in OSCAR EMR

Unlisted  
26 views

OSCAR EMR Video Tutorial Series  
Unlisted OSCAR EMR Tutorials - 3 / 4

- Video 1: Coding Diabetic Patients in OSCAR EMR (4:26)
- Video 2: Creating Diabetes Recalls in OSCAR EMR (4:48)
- Video 3: Recording Hemoglobin A1C and Blood Pressure in OSCAR EMR (3:41)
- Video 4: Ordering Diabetic Lab Testing in OSCAR EMR (4:06)

Video 2 Revised  
OSCAR EMR Tutorials  
1 view

**In Video 3, you learned how to:**

Record Blood Pressure and Hemoglobin A1C in OSCAR EMR

3:24 / 3:40

Video 3: Recording Hemoglobin A1C and Blood Pressure in OSCAR EMR  
Unlisted

OSCAR EMR Video Tutorial Series  
Unlisted OSCAR EMR Tutorials - 3 / 4

- 1 Video 1: Coding Diabetic Patients in OSCAR EMR  
OSCAR EMR Tutorials  
4:26
- 2 Video 2: Creating Diabetes Recalls in OSCAR EMR  
OSCAR EMR Tutorials  
4:48
- 3 Video 3: Recording Hemoglobin A1C and Blood Pressure in OSCAR EMR  
OSCAR EMR Tutorials  
3:41
- 4 Video 4: Ordering Diabetic Lab Test in OSCAR EMR  
OSCAR EMR Tutorials  
4:06

Video 2 Revised  
OSCAR EMR Tutorials  
1 video

Please **practice** using the features introduced in this Diabetes Care Management video tutorial series.

3:45 / 4:05

Video 4: Ordering Diabetic Lab Testing in OSCAR EMR  
Unlisted

OSCAR EMR Video Tutorial Series  
Unlisted OSCAR EMR Tutorials - 4 / 4

- 1 Video 1: Coding Diabetic Patients in OSCAR EMR  
OSCAR EMR Tutorials  
4:26
- 2 Video 2: Creating Diabetes Recalls in OSCAR EMR  
OSCAR EMR Tutorials  
4:48
- 3 Video 3: Recording Hemoglobin A1C and Blood Pressure in OSCAR EMR  
OSCAR EMR Tutorials  
3:41
- 4 Video 4: Ordering Diabetic Lab Testing in OSCAR EMR  
OSCAR EMR Tutorials  
4:06

Video 2 Revised  
OSCAR EMR Tutorials  
1 video

## Appendix C: Study Invitation Letter



### OSCAR EMR Training Opportunity

Dear Physicians using OSCAR EMR,

Are you interested in finding out more about how to use your EMR to improve diabetes care management for your diabetic patients and make better use of the GPForMe billing incentives for your diabetic patients?

A research team from the University of Victoria is undertaking a research study to evaluate an EMR video tutorial designed to support primary care physicians with managing diabetes care for their patients.

**Potential benefits to participating physicians include:**

- Access to newly developed EMR training for diabetes care management
- Improved tracking and documentation of diabetes care to ensure guideline-informed care and facilitate the billing of diabetes care incentives (i.e., G14050).
- Opportunity to provide feedback for EMR training enhancements
- Contribution to new research
- Dissemination of findings throughout the Divisions of Family Practice and Health Data Coalition

Participation in this study is voluntary and will require approximately 75 minutes of your time. A select number of physicians (n=20-30) will also be invited to participate in two 30-60 minute interviews. No compensation or CME credits will be provided for participating in the study activities.

**Who can participate?**

To participate in this study, you must:

- a. Be a full service family physician (FSFP);
- b. Be a member of a Division of Family Practice;
- c. Use the OSCAR EMR;
- d. Work in a solo or group practice;
- e. Have diabetic patients in your practice; and
- f. Be interested in implementing and applying the intervention in your practice, including using the advanced features of your EMR for diabetes care management.

If you would like to participate in the study, please sign the attached consent form and return it via toll-free fax ( ) or email the study investigator Gurprit Randhawa at

For more information or to find out how to participate please contact:

Gurprit Randhawa (Principal Investigator) at  
 PhD Student, School of Health Information Science  
 University of Victoria

## Appendix D: Study Consent Form



### ***Participant Consent Form***

---

**Project Title:** Evaluating the Effects of a Post-Implementation EMR Training Intervention for Diabetes Care Management in Primary Care

**Researcher(s):**

Gurprit Randhawa (Principal Investigator), University of Victoria,  
 Karen Courtney (Co-Investigator), University of Victoria,  
 Aviv Shachak (Co-Investigator), University of Toronto,  
 Andre Kushniruk (Co-Investigator), University of Victoria,

**Purpose(s) of the Research:**

The purpose of this study is to evaluate the effects of an electronic medical record (EMR) training intervention for diabetes care management in primary care. The training will be based on the Chronic Care Model (CCM) and provided to primary care physicians (PCP).

Specifically, the research aims to address the following questions:

1. To what extent does a CCM-based post-implementation EMR training intervention affect the process measures for type 1 and type 2 diabetes care management, including (a) use of a diabetes registry, (b) use of diabetes recalls/reminders, (c) ordering/viewing a patient's Hemoglobin A1C every 3-6 months, and (d) recording a patient's blood pressure every 3-6 months?
2. What are the barriers and facilitators to applying the CCM-based post-implementation EMR training into PCPs' practice?

**This Research is Important because:**

Diabetes care gaps can cause serious complications for patients and increased costs for the Canadian health care system. A British Columbia (BC) study found that adults with diabetes used, on average, 2.4 times the health resources of the general population. Hence, diabetes care is a priority condition for policy-makers, health system managers and health care providers. EMRs have been widely adopted in physician offices throughout BC. To enable maturity of EMR use to realize benefits realization, EMR training and support has been identified as a national research priority. This research has health care policy implications for planning the post-implementation EMR training and support to address the care gaps in diabetes care and other chronic diseases. Researchers, practitioners, and decision-makers can apply the findings of this research to design training interventions and examine their effects on EMR benefits realization, including EMR use, user satisfaction, and net benefits (quality, access, productivity). Moreover, this research has potential international implications for health care systems that are working to redesign primary care to (a) support proactive, planned care of their diabetic patients, (b) decrease health care costs, and (c) improve the quality of life of diabetic patients.

**Participation:**

- You have been selected to participate in this study because you are (a) full service family physician (FSFP), (b) a member of a Division of Family Practice, user of OSCAR EMR, (c) work in a solo or group practice, (d) have diabetic patients in your practice, and (e) are interested in implementing and applying the intervention in your practice, including using the advanced features of your EMR for diabetes care management
- Participation in this project is entirely voluntary.
- Whether you choose to participate or not will have no effect on your position (e.g. employment) or how you will be treated.

**Procedures:**

If you agree to participate in the study, you will be provided with a demographic/baseline survey to complete. One month later, you will receive access to a series of EMR video tutorials to watch, as well as a link to a Diabetes Care Management Survey to complete. At three months and six months after viewing the video tutorials, you will be sent the Diabetes Care Management Survey to complete again. A small group of physicians will also be interviewed regarding their barriers and facilitators to applying the EMR training into practice. Responses will be audio-recorded (audio-taped) by the PI. The audio-recordings will also be transcribed and combined with notes for analysis.

- **Duration:** 75-210 minutes
- **Location:** At your convenience
- **Inconvenience:** Time may be required to complete activities

**Compensation:**

- No compensation will be provided for participating in the study.

**Benefits:**

For study participants, the expected benefits include but are not limited to:

- (a) Access to newly developed EMR training for diabetes care management
- (b) Improved tracking and documentation of diabetes care to ensure guideline informed care and facilitate the billing of diabetes care incentives (i.e., G14050).
- (c) Opportunity to provide feedback for EMR training enhancements
- (d) Contribution to new research
- (e) Dissemination of findings throughout the Divisions of Family Practice and Health Data Coalition

For OSCAR EMR-Authorized Service Providers, the expected benefits include but are not limited to:

- (a) User feedback for EMR training improvement

For society and state of knowledge the benefits are:

- (a) Tested video tutorial tool for future EMR training
- (b) Dissemination of findings (experiences, potential problems, advice) to practices planning EMR training and quality improvement efforts for diabetes care management
- (c) Potential improvement in diabetes care management

**Risks:**

- There are no known or anticipated risks to you by participating in this research

**Withdrawal of Participation:**

- You may withdraw at any time without explanation or consequence.
- Should you withdraw, you will be asked if you agree to the use of your data.

**Continued or On-going Consent:**

- Data collection will occur over six months. By signing this form you are agreeing to your ongoing consent for the entire duration of the research. At each data collection point, we will remind you that your participation is voluntary and that you are free to withdraw from the study at any point without consequence or explanation.

**Anonymity and Confidentiality:**

- Anonymity will be limited due to the nature of data collection activities, however all data will be anonymized during dissemination of results
- Confidentiality will be protected by anonymizing participants during coding and summarizing. If direct quotes are used in reporting, identifying information will be removed. All collected data will be stored in a locked cabinet or in a password-protected file storage location accessible only to the Principal Investigator.

**Disposal of Data:**

- Data will be kept for seven years after the study is complete.
- Files will be deleted and paper notes will be shredded.

**Research Results may be Used/Disseminated in the Following Ways:**

- Shared with OSCAR EMR-Authorized Service Providers
- Disseminated throughout the Divisions of Family Practice, General Practice Services Committee (GPSC) and the Health Data Coalition
- Published in scholarly articles and presented for knowledge sharing
- Included in short videos to disseminate the study findings to patients, physicians, and health care decision-makers
- The concept of video tutorials as an EMR training intervention may have a commercial potential for EMR vendors/service providers in the future. However, the study data will not be used for a commercial purpose. If EMR vendors/service providers choose to commercialize EMR video tutorials as a result of this study, participants would potentially have access to more training to improve their use of the EMR across a range of functions/features and disease conditions

**Questions or Concerns:**

- Contact the researcher(s) using the information at the top of page 1;
- Contact the Human Research Ethics Office, University of Victoria, (250) 472-4545 [ethics@uvic.ca](mailto:ethics@uvic.ca)

**Follow-Up Interviews:**

Please indicate if you are interested in participating in follow-up interviews that will be held three and six months after the study intervention:  Yes  No

**Consent:**

Your signature below indicates that you understand the above conditions of participation in this study and that you have had the opportunity to have your questions answered by the researchers.

\_\_\_\_\_  
*Name of Participant*

\_\_\_\_\_  
*Signature*

\_\_\_\_\_  
*Date*

**Participant Email (to send the study survey):** \_\_\_\_\_

**Phone Number:** \_\_\_\_\_ **Fax Number:** \_\_\_\_\_

***A copy of this consent will be left with you, and a copy will be taken by the researcher.***

**Note:** Please sign the attached consent form and return it via toll-free fax ( ) or email to

## Appendix E: Demographic Survey and Diabetes Care Questionnaire

1. Please check off the EMR video tutorials that you have fully watched:

- Video Tutorial 1: Creating a diabetes registry
- Video Tutorial 2: Creating diabetes recalls/reminders
- Video Tutorial 3: Recording a patient's Hemoglobin A1C
- Video Tutorial 4: Recording a patient's blood pressure

*Note: Please ensure that you watch all of the video tutorials before submitting this survey.*

2. Age (years)

- a. <35
- b. 35-44
- c. 45-54
- d. 55-64
- e. 65+

3. Sex

- a. Male
- b. Female

4. Health Authority/ Location of Practice

- a. Fraser Valley
- b. Interior
- c. Vancouver Coastal
- d. Vancouver Island

5. Years of Practice

- a. <4
- b. 5-9
- c. 10-14
- d. 15-19
- e. 20+

6. Type of practice

- a. Solo
- b. Multi-physician

7. Years of EMR Experience

- a. <1
- b. 1-2
- c. 3-4
- d. 5-9
- e. 10-14
- f. 15+

8. Number of EMRs used
  - a. 1
  - b. 2
  - c. 3
  - d. 4
  - e. 5+
  
9. Have you received prior post-implementation EMR training?
  - a. Yes
  - b. No
  
10. How would you rate your computer skills?
  - a. Low
  - b. Average
  - c. Above Average
  - d. High
  - e. Computer Expert
  
11. How would you rate your EMR Skills?
  - a. Low
  - b. Average
  - c. Above Average
  - d. High
  - e. EMR Expert
  
12. Approximately how often do you order Hemoglobin A1C for your stable diabetic patients?
  - f. Every 3 months
  - g. Every 6 months
  - h. Every 9 months
  - i. Every year
  - j. Other: \_\_\_\_\_
  
13. Approximately how often do you order Hemoglobin A1C for your unstable diabetic patients?
  - a. Every 3 months
  - b. Every 6 months
  - c. Every 9 months
  - d. Every year
  - e. Other: \_\_\_\_\_
  
14. Approximately how often do you measure Blood Pressure for your stable diabetic patients?
  - a. Every 3 months
  - b. Every 6 months
  - c. Every 9 months
  - d. Every year
  - e. Other: \_\_\_\_\_

15. Approximately how often do you measure Blood Pressure for your unstable diabetic patients?
- Every 3 months
  - Every 6 months
  - Every 9 months
  - Every year
  - Other: \_\_\_\_\_
16. Overall for what percentage of your diabetic patients do you routinely assign the “250” ICD code in the patient’s problem list in the EMR **to ensure that your patients can be identified as diabetics?**
17. Follow-up visits are routine visits that are conducted every 3-6 months after a patient is diagnosed with diabetes. **To ensure that your patient can be identified as having diabetes and to ensure accurate billing or resource use:**
- For what percentage of your **stable** diabetic patients do you routinely assign the "250" ICD-9 code in the EMR for nearly all or all diabetes follow up visits?
  - For what percentage of your **unstable** diabetic patients do you routinely assign the "250" ICD-9 code in the Diabetes EMR template for nearly all or all diabetes follow up visits?
18. For what percentage of your **stable** diabetic patients:
- Have you ever created a diabetes recall/reminder?
  - Do you order/view Hemoglobin A1C in the EMR at all or nearly all diabetes follow-up visits?
  - Do you record blood pressure in the EMR at all or nearly all diabetes follow-up visits?
19. For what percentage of your **stable** diabetic patients:
- Have you ever created a diabetes recall/reminder?
  - Do you order/view Hemoglobin A1C in the EMR at all or nearly all diabetes follow-up visits?
  - Do you record blood pressure in the EMR at all or nearly all diabetes follow-up visits?
20. Please feel to share how you use the EMR for diabetes care management.

## **Appendix F: Interview Guides**

### **O3 - OSCAR EMR Interview Questions**

1. Which EMR features from the training did you choose to use and why?
2. Which EMR features from the training did you choose not to use and why?
3. What helped with the integration of the EMR training into your diabetes care management for patients?
4. What interfered with the integration of the EMR training into your diabetes care management for patients?
5. Did you find the EMR training helpful? Why or why not.
6. Was something missing in the EMR training?
7. Is there something you could use to aid your decision-making for diabetes care management?
8. Did anything surprise you about the EMR training?
9. What role can the EMR play in helping to improve process measures for diabetes care management?
10. What role can the EMR play in helping to improve clinical indicators for diabetes care management?
11. Do you have ideas for improving the EMR training?
12. What advice would you give to someone in a similar situation (i.e., a physician interested in improving diabetes care management for their patients using their EMR)?

## O4 - OSCAR EMR Interview Questions

Thank you again for participating in the interview! I have a series of open-ended questions. May I ask your permission to record the interview?

1. You participated in the three-month follow up interview. What has changed since the last interview?
2. What has interfered with integrating the EMR training into your practice (i.e., barriers)?
3. What has helped with integrating the EMR training into your practice (i.e., facilitators)?
4. Have you taken any additional steps to improve your EMR use in general? What about diabetes care management in particular?
  - Probe: Additional Training, Individual Trial and Error, Other forms of Support (e.g., impersonal)
5. Are there any other forms of end-user support that you would find helpful to supplement the video tutorials?
  - Probe: Would a cue card be a useful supplement to the video tutorials?
6. What do you believe are the characteristics of an effective trainer/host for EMR video tutorials for physicians? For MOAs?
  - Probe: Knowledge, Homophily, Counselling and Communication Skills
7. What is the best way to reach physicians to tell them about video tutorials or to package it for them?
  - Probe: Would a postcard to the office describing how to get online training work? Does it need to be a 1:1 recommendation from another physician? What about professional newsletters or other organizational contacts?
8. Do you have ideas for improving the EMR training?
9. That's the last question I have for you! Do you have any other additional comments or suggestions you would like to share?

## Appendix G: Qualitative Data Codebook

Code	Sub-Code	Description
Additional Comments and Suggestions	N/A	Maps to the O3 interview that was asked at the end of the interview: Do you have any addition comments or suggestions you would like to share?
Advice to Physicians	N/A	Maps to O3 Interview Question #12: What advice would you give to someone in a similar situation (i.e., a physician interested in improving diabetes care management for their patients using their EMR)?
Decision-Making Aids for Diabetes Care Management	N/A	Maps to O3 Interview Question #7: Is there something you could use to aid your decision-making for diabetes care management?
EMR Features	10 sub-codes, as outlined below.	This node includes responses from: (a) O3 interviews related to Interview Question #1 (Which EMR features from the training did you choose to use and why?) and #2 (Which EMR features from the training did you choose not to use and why?), (b) O4 interview Question #1 (You participated in the three-month follow up interview. What has changed since the last interview?), and (c) open-ended question in the O1-O4 DCM Questionnaire.
	Awareness of EMR Features	The PCP's awareness of the EMR features for diabetes care prior to the training intervention.
	Changes since O3	Maps to O4 interview Question #1: You participated in the three-month follow up interview. What has changed since the last interview?
	EMR Features Already Used Prior to Training	EMR features that the physician was using prior to the EMR training.
	EMR Features Not Used from Training	EMR features that the physician did not use from the EMR training. This maps to O3 interview Question #2: Which EMR features from the training did you choose not to use and why?
	EMR Features Not Used Prior to Training	EMR features from the training that the physician did not use prior to the training.
	EMR Features Used from Training	EMR features from the training that the physician has implemented into their practice. This maps to O3 interview question #1: Which EMR features from the training did you choose to use and why?
	EMR Features Used that were Not Included in Training	EMR features not covered in the training that the physician is using.
	Perception of EMR Use for Diabetes Care	Includes answers about physicians' self-perception of use from the open-ended question in the O1-O4 DCM Questionnaire.
	Unused EMR	EMR features that the physician is using that were not

Code	Sub-Code	Description
	Features (Not from Video Tutorials)	covered in the EMR training.
	Useful EMR Features	EMR features that the physician finds useful.
EMR Issues	Three sub-codes, as outlined below.	EMR issues that the physician has reported in the interviews. These issues do not relate to the EMR training.
	Additional Functionality Wanted	Additional EMR functionality that the physicians would like.
	EMR Costs	Cost-related issues that the physician has with the EMR.
	Data Issues	Data-related issues, such as lack of EMR data autopopulation.
EMR Training	14 sub-codes, as outlined below.	Relates to the EMR training (video tutorials) intervention that was delivered.
	Barriers	Maps to O3 Interview Question #4 and O4 Interview Question #2: What interfered with the integration of the EMR training into your diabetes care management for patients?
	Facilitators	Maps to O3 Interview Question #3 and O4 Interview Question #3: What helped with the integration of the EMR training into your diabetes care management for patients?
	Format	Terms used by physicians to describe the video tutorials, such as "short", "accessible" and "handy". Maps to O3 Interview Question #5: Did you find the EMR training helpful? Why or why not.
	Helpfulness of EMR Training	Maps to O3 Interview Question #5: Did you find the EMR training helpful? Why or why not.
	Improvement Ideas	Maps to O3 Interview Question #11 and O4 Interview Question #8: Do you have ideas for improving the EMR training?
	Missing Components	Maps to O3 Interview Question #6: Was something missing in the EMR training?
	Other EMR Training Topics of Interest	Other EMR training topics that the physician is interested in learning about, which were not covered in the training.
	Physician Facilitator	The competencies and characteristics of the physician facilitator of the EMR training. This includes physicians' preferences about having a physician facilitator for the training.
	Potential Uses	Potential use of the EMR training, such as for medical residents or locum physicians.
	Process for Watching Video Tutorials	Comments about the process of watching the EMR video tutorials.
	Recall of EMR Training	How well physicians remembered the EMR training. This code indicates that they were having challenges remembering the EMR training.

Code	Sub-Code	Description
	Role in Motivating Increased EMR Use	The role that the EMR training and research study has played in motivating increased EMR use by physicians.
	Supplements	Maps to O4 Interview Question #5: Are there any other forms of end-user support that you would find helpful to supplement the video tutorials?
	Surprises	Maps to O3 Interview Question #8: Did anything surprise you about the EMR training?
MOA Characteristics	N/A	MOA characteristics that physicians have described in supporting/hindering diabetes care management.
Other End User Support (EUS)	15 sub-codes, as outlined below.	Other end-user support (EUS) that the PCP receives that is not included in the EMR training intervention.
	Additional Steps taken since O3	Maps to O4 Interview Question #4: Have you taken any additional steps to improve your EMR use in general? What about diabetes care management in particular?
	Children	EUS received from the PCPs' children.
	Cost	The cost of EUS.
	In Clinic Support from Physician Peers	EUS received from in-clinic physician peers.
	In-Person EUS	EUS received in-person.
	Meaningful Use (MU) Program	EUS received as a part of the Physician Information Technology Office MU program.
	Objective Data Dashboard	An EMR data dashboard that shows PCPs' use of selected EMR features.
	OSCAR Service Provider	EUS received from the OSCAR Service Provider.
	OSCAR Super-User Support	EUS received from an OSCAR Super-User.
	OSCAR Support Meetings	EUS received from OSCAR Support Meetings.
	OSCAR User Community	EUS received from the OSCAR user community.
	Peer Learning and Mentorship Group	EUS received from non-OSCAR physician learning groups.
	Physician Colleagues	EUS received from physician colleagues.
	Quality Improvement Support	EUS received from quality improvement personnel.
User Documentation	EUS received from reviewing EMR user documentation, such as help manuals.	
Participant Characteristics	N/A	The characteristics of the participants that have emerged from the interviews through self-report.
Primary Care Reform	N/A	Comments related to primary care reform that emerged from the O3 interviews.
Role of EMR	Three sub-codes, as	Maps to O3 Interview Questions # 9 (What role can the

<b>Code</b>	<b>Sub-Code</b>	<b>Description</b>
	outlined below.	EMR play in helping to improve process measures for diabetes care management?) and #10 (10. What role can the EMR play in helping to improve clinical indicators for diabetes care management?)
	Improve Clinical Indicators for DM	Maps to O3 Interview Question #10: What role can the EMR play in helping to improve clinical indicators for diabetes care management?
	Improve Process Measures for DM	Maps to O3 Interview Question #9: What role can the EMR play in helping to improve clinical indicators for diabetes care management?
	Improving Patient Care	The role that the EMR can play in improving patient care.
Usability	N/A	Comments related to improving usability of the EMR.

## Appendix H: HDC Letter



Better Information. Better Care. Better Patient Outcomes.

April 25, 2017

Gurprit K. Randhawa  
PhD Candidate  
School of Health Information Science  
University of Victoria

**Re: HDC Application for Data Use and Disclosure entitled "Evaluating the Effects of a Post-Implementation EMR Training Intervention for Diabetes Care Management in Primary Care"**

Dear Gurprit,

Thank you for your application for use of the HDC network and HDC aggregate data in support of your PhD study. Given our technical development timeline for the deployment of endpoints and implementation of the universal schema for multiple EMRs, we expect to be able to support researcher requests starting in 2018. While the HDC supports the premise of your research proposal, we feel we are not now able to support this request.

Please sign up for our newsletter at [www.hdcbc.ca](http://www.hdcbc.ca) so that you can keep abreast of our developments and feel free to call me if you have further questions.

Sincerely,

per

Dr. Tracy Monk  
Chair  
Clinical Data Governance Committee  
Health Data Coalition